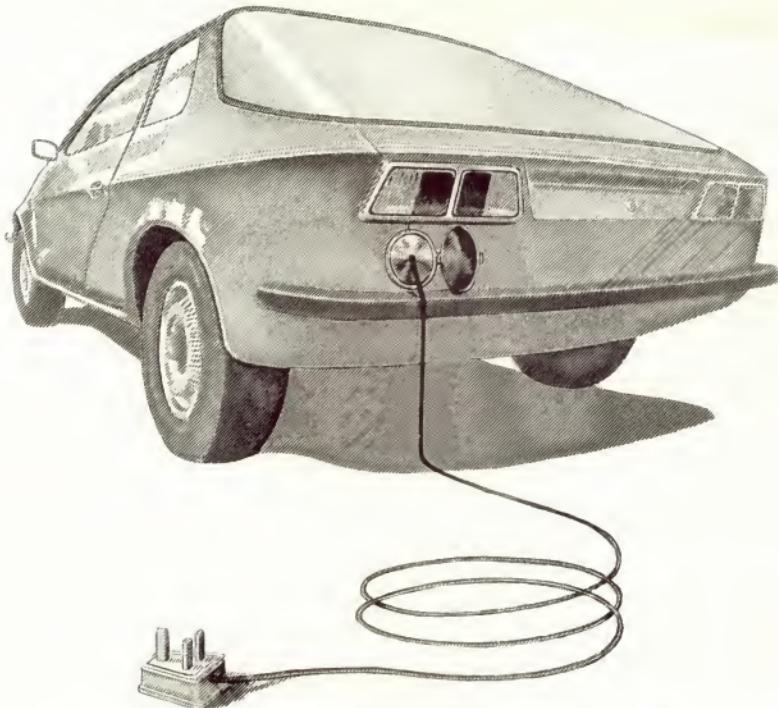


# newscientist



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Tom Butler makes plastic plants and sells designs for reinforced concrete shelters, and the equipment to go with them; this shelter will hold seven people and cost around £9000. His company, Nuclear Protection, Northants, is one of more than 300 in Britain aspiring to save us from the bomb. Laurence Godfrey surveys the market and explains what to look for (see p 274).

Cover by: Pete Addis

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This One



# Comment

## The great unwatched

The continuing investigation of the "D-notice" system of press censorship by the House of Commons Select Committee on Defence may be good clean fun for the lads in Fleet Street who like to make life difficult for the military, but this really is a trivial issue alongside the broader issue of public access to government information. D-notices—the voluntary system whereby a committee of very important people tries to keep sensitive titbits about Britain's military might from being spread too liberally by the press—have come in for some knockabout treatment by the *New Statesman*, which this week had the privilege of telling the Select Committee what it thought of D-notices. But isn't it all rather irrelevant? Do most people care about the shenanigans of the defence establishment?

There are many people who are not only unconcerned about the whereabouts of military spy holes but who also do not want everything in this area revealed because they have a sneaking suspicion that we have a few enemies and would-be enemies in the world, and that those foes should remain ignorant of our military secrets. No; the real nest of worms is not the Ministry of Defence but the ministries of everything else and those other public bodies whose operations are even more opaque than those of the civil service—and this has to include that great monolith the Post Office, which must owe some of its current demotion to its failure to keep its customers, who are also its "owners", informed about its activities. (In the light of the PO's inability to get the simplest thing right, it sometimes smacks of Wonderland to suggest that this bunch of incompetents could act as the centre of a national bugging network.) Any reporter who is really concerned about the public's "right to know" should ignore the demi-monde of the overgrown schoolboys playing soldiers and spies and should instead concentrate on the far harder problem of official obscurantism.

Unfortunately, by pushing the MoD's watchdog in the House of Commons into investigating D-notices, the unmaskers of buggers are guaranteeing that the more important and wider issue of the Official Secrets Act goes unnoticed. This is because it is one of those rules of the House that select committees do not stray into each others' territory, so while Defence concerns itself with matters appertaining to the Official Secrets Act—surely any study of D-notices must hinge on this—other MPs won't touch that purveyor of darkness.

Why does government secrecy—to be fair, in some departments it isn't so much secrecy as evasiveness and a lack of candour—bother us when our role in life is to report the goings on of the scientific establishment in the broadest sense? The refusal to be open concerns us because the Official Secrets Act infuses every part of government with its unsavoury influence, and government is, of course, the largest employer of scientists in Britain.

A discredited and decidedly vague weapon against freedom of information, the Official Secrets Act affects government in an insidious way. It breeds a frame of mind of secrecy rather than openness in civil servants in Britain. It is, by contrast, a pleasure to talk to a government employee in the United States—home of the Freedom of Information Act—because there the civil servants don't even need prompting to reveal all. There's none of this "talk to our press office"—the standard response in Whitehall. (You try holding a dialogue on a complex topic through an intermediary and see how far you get before giving up or becoming hopelessly confused.)

A government that embraces an Official Secrets Act is

saying that it is the done thing to keep your mouth shut. And many of the grey people in Whitehall readily latch on to this as a way of guaranteeing a quiet life—even when faced with unsavoury information that they know in their hearts should be passed on to the public.

This is not a new debate; it has been going on for years, but we have had recent (broken) promises of change. And the Defence Select Committee must talk about the Official Secrets Act when it reports on the issue of D-notices. It should tell the government to separate the military secrets from the civil secrets. People, and most journalists are people, will respect military secrets more if they are not forced to use devious tactics to coax even the most innocent information out of officialdom. It is, in any instance, counterproductive to stamp "confidential" on every government document as this pushes journalists into blowing up otherwise harmless pieces of paper into things of importance. No one is asking the government to trust the press with its innermost thoughts, just with the information that the people of Britain have every right to know.

## Dial M for murder

If one side keeps on losing a game, then surely the time is ripe to change the rules. That probably isn't why the government is rewriting the rules of the game of monopoly indulged in by a number of state-owned industries, but if the effects are right then something sensible will have been achieved as a result of the Conservatives' adherence to their otherwise less than wholly rational dislike of nationalisation as a philosophy. For years the customers have lost consistently in the monopoly game run by the Post Office. And it is, oddly enough, the seemingly successful and highly profitable telecommunications side that had been making fools of us all. (Just as it is the British Gas Corporation, most profitable of all the nationalised energy utilities, that seems to care more for itself than for its consumers.)

There cannot be many people who are without some tale of telephonic incompetence. Our own horror story is of an office that has remained empty for nearly a year—at no small cost—while the PO's telecommunications department breaks promise after promise over equipment deliveries. Repeat that same story throughout British business, and you wonder quite how much we can blame the Post Office for the decline of British industry.

By clearing the way for independent organisations to supply equipment for attachment to the British telephone network, the government has made it possible for telephone users to jump out of the 19th century into the 20th. And Sir Keith Joseph seems to have got it about right in the "demonopolisation" of Post Office Telecommunications. The PO will still provide the network and the first receiver—thus ensuring that it can maintain the integrity of its system and keep tabs on the sort of gadgetry that is attached to it—and there is to be time for British industry to jump into the business of making all those wonderful gadgets that can be plugged into a telephone system.

It will take the companies some time to throw off the straitjacket imposed on them by years of Post Office technical conservatism, but the opportunities are so large that any electronics company with any vision will see this as an opportunity to break into a potentially valuable business. Industry all-but missed the boat when it failed to take advantage of a similar Post Office embargo on foreign equipment for Prestel. Let us hope that it does not dither this time.

Michael Kenward

# This week

## Engine failures leave Ariane grounded

Peter Marsh, Paris

French engineers investigating the failure on its second flight of Ariane, the European Space Agency's satellite launcher, this week agreed to a new series of tests that will delay further flights by three months. The hold up could jeopardise commercial contracts for Ariane, which, according to ESA's plans, will launch a quarter of the satellites that the world puts into orbit over the next ten years.

About 40 engineers in technical establishments around Paris are investigating the accident, which happened two months ago. The rocket, whose development is costing ESA's 11 member nations some £500 million, crashed into the Atlantic Ocean less than two minutes after leaving its launch pad in Kourou, French Guiana.

Jean Gruau—who, as the general inspector of CNES, the French space agency, is coordinating the investigation—estimates that one of 200 000 factors could have caused the accident. So far his team has not established what went wrong. This week Gruau said that because of this, Ariane's next test flight, scheduled for November, will now take place in February at the earliest.

While the engineers investigate why the setback happened, ESA's administrators have another problem. This concerns who will fund the next stage in Ariane's development. There is a possibility that France, whose taxpayers are already footing some 70 per cent of the total bill for the project, may decide to fund all of the next phase of development.

So far, ESA has agreed to develop the rocket to the point where it can lift a 2.4 tonne satellite into geostationary orbit. Such rockets, slightly modified versions of the one that crashed in May, will constitute the Ariane "fleet" until the mid-1980s. Plans already exist for the

more powerful rockets that will replace them. These would lift up to 3.5 tonnes. The development of the new rockets will cost about £55 million. However, ESA will consider these plans only next summer.

This schedule does not look attractive to ArianeSpace, the company set up earlier this year to sell Ariane rockets. ArianeSpace wants a decision by the end of the year on whether the new rocket will go ahead. This is because Intelsat, the international telecommunications organisation, is interested in buying one of the more powerful Arianes to launch a series of new, heavy communications satellites beginning in 1985. And to fit its own satellite development programme with the specifications for the launcher, Intelsat must know by December plans for the modified Ariane.

According to Klaus Iserland, ArianeSpace's deputy director general, his company's chances of commercial success will be greatly helped if the new version of the rocket is available by 1984. The rocket would then be able to compete with the US's space shuttle—assuming the shuttle is operating by then—far more effectively than the less powerful,

current versions of Ariane. If the other members of ESA dither over funding the new development, France may step in to fund all of it and so help out ArianeSpace—60 per cent of which is owned either by the French government or by privately-owned French firms.

Of course, ArianeSpace may have to modify its sales plans unless the investigation into the second test flight produces an explanation for the failure. Two further test flights are planned before Ariane's "operational" programme starts next summer, when organisations will pay up to £17 million to have their satellites put into orbit. (ESA will manage the first six launches in this programme; ArianeSpace assumes responsibility for later launches.)

Because of lack of progress in the investigation into the May accident, technicians at a test facility in Vernon run by SEP, a French aerospace company, started this week to take apart the rocket for the third test flight. This will set back the launch programme by at least three months.

The SEP team will check the injectors in each of the four engines in the rocket's first stage. A similar engine ➤

## Britain's enterprising backing for bugs

The National Enterprise Board yesterday unveiled long-awaited plans for Britain's first biotechnology firm. The budget of the new firm, possibly called Celltech, will, at first, be modest: between £10 million and £12 million over the next four or five years. The idea, according to NEB spokesman, is to keep the venture "lean and hungry", and looking for projects which will be cash generating within 2-3 years. The NEB put up a large proportion of the money and so owns 40-50 per cent of the equity, but has managed to persuade four private investors—Prudential Assurance, the Midland Bank, Technical Development Capital (a venture capital company) and British and Commonwealth Shipping—to chip in with the rest for about 15 per cent of Celltech's equity each.

The formation of such a venture capital firm was one of the principal recommendations of the Spinks report on biotechnology, published last March by a prestigious joint working party which included the Advisory Council on Applied Research and Development (*New Scientist*, 3 April, p 3). However, the NEB view differs in one important respect from the Spinks report: there are no plans for close, formal cooperation with the National Research Development Corporation over Celltech. NEB spokesmen insist there will, however, be no conflict with the NRD (which among other things handles the patents of scientists employed by the British government and universities) as most of Celltech's schemes will not be patentable.

Although the new firm is loosely

modelled on its American counterparts, Cetus and Genentech, Celltech will not "buy scientists" by offering them a stake in the company. Instead, as NEB's Gerard Fairtough, who will be Celltech's first managing director, told *New Scientist*, a closer relationship based on frequent consultations with scientists doing the basic research should winkle out ideas worth exploiting commercially. Celltech will also rely on contracts to get a lot of research in genetic engineering done.

During the next few months, Fairtough, must find good technical and planning managers, a large enough laboratory within easy reach of London, and of course, suitable "cash generating" projects. Initially Celltech's most important scientific partner will be Sydney Brenner's Unit of Molecular Biology at Cambridge, part of the Medical Research Council, and where Cesar Milstein pioneered the research on monoclonal antibodies. It is here that Fairtough thinks that the early commercial successes in the production of vaccines and diagnostic reagents will come. Although Celltech will let the big pharmaceutical houses tackle the expensive development of therapeutic wonder drugs, such as interferon, Fairtough believes that Celltech will have the resources for big projects, such as with the huge markets for gasohol in mind, improving the alcohol yield of yeasts. Despite all these problems, Fairtough, who was joint managing director of Shell UK before joining the NEB, is really looking forward to managing Celltech. "It should be enormous fun."

## Observer



# This week

continued

◀ misbehaved during the first five seconds of the May flight, causing the rocket to go out of control shortly afterwards. The technicians will ensure that the injectors—tiny pipes that feed liquid fuel into the combustion chamber of each engine—are correctly positioned. If even one of the 864 injectors in each engine directs fuel at the wrong angle, combustion could take place unevenly, leading to vibrations which could cause the spacecraft to break up. Investigators think it is possible that some of the injectors in the second test launch were incorrectly positioned.

Injector malfunction is just one of the factors that could have caused the accident. Another theory is that a combination of vibrations, transmitted through the pipes that feed fuel to the combustion chamber, produced a sound wave of the frequency at which the chamber resonates. This would have caused oscillations that, transmitted through other parts of the spacecraft, fractured structural connections.

To test this theory, the engineers will examine changes in variables, such as temperature and pressure, at different parts of the spacecraft. They have a record of these changes, thanks to data transmitted from the rocket before it plunged into the Atlantic. Big changes in several variables within a few milliseconds of each other could indicate the part of the rocket where something went wrong—and which caused vibration. This approach takes a long time, however. The variables have to be plotted by hand on graph paper; and they have to be accurate to a few milliseconds, so that they can be correlated with each other. The use of computers is ruled out as, according to the French investigators, they are not clever enough for the job. □



The combustion chamber in one of Ariane's engines: did vibration cause the big crash?

## Is South Africa a nuclear power?

Lee Torrey, Boston

New evidence released by the Carter administration last week has refueled the debate over whether the Republic of South Africa has become the world's seventh nuclear power. A White House task force report published on 15 July states that the intense flash of light spotted by a Vela satellite near South Africa last September "was probably not from a nuclear explosion." These findings, however, were promptly challenged by the Pentagon, which argued that the unique signature of the mystery flash suggests that it came from a low yield nuclear detonation in the atmosphere, possibly from a neutron bomb.

According to the White House report, the light signal of 22 September was detected by two instruments aboard the Vela satellite known as bhangmeters—devices that observe incident light and trigger a recording apparatus when light intensity changes rapidly. The Vela bhangmeters have recorded many previous nuclear explosions, as well as light from super bolts of lightning and cosmic ray particles. In addition, they have been triggered several hundred times by signals of unknown origin, which are called "zoo events."

The signature of the 22 September flash has many features of signals previously observed only from a nuclear explosion, including the right time duration and a characteristic "double-humped pulse" which was recorded by both bhangmeters. The double-hump results when the fireball of an atomic explosion is momentarily blacked out by the shock wave surrounding the explosion, then reappearing with greater intensity as the shock wave dissipates.

Despite the double-humped signature of the 22 September flash, the White House report found that a slight but significant deviation in the relative intensity of signals recorded in the two Vela bhangmeters throws doubt on its interpretation as a nuclear event. "Although we cannot rule out the possibility that this signal was of nuclear origin," the report states, "we consider it more likely that the signal was one of the 'zoo events, possibly a consequence of the impact of a small meteoroid on the satellite."

An administration official explained that the double-humped signal might have been caused by a small meteoroid moving at very high velocity, striking the surface of the Vela satellite, giving rise to a number of slow moving fragments which could float out from the satellite. If these debris fragments floated in front of the few of the bhangmeters, they could reflect the sunlight in a way that would resemble the double-hump on a nuclear detonation. This official conceded that this type of event could be expected to happen only once every 10 years.

The White House study is champion-

ing a meteorite explanation in part because it can find little supporting evidence for the nuclear explosion hypothesis. Soon after the Vela satellite picked up the optical signal, US Air Force C-135 transport planes and U-2 reconnaissance craft were crisscrossing the area to detect radioactive debris from the explosion, but found none in excess of background level. In mid-November, a health physics laboratory in New Zealand reported finding traces of shortlived fission products in their rainwater, but these results were later withdrawn and are not considered reliable.

One explanation being put forward by the Pentagon is that the explosion may have been that of a neutron bomb—a weapon which does not produce the high quantities of radioactive fallout found in conventional nuclear devices. A neutron bomb might also explain the low strength of the 22 September event—no more than 10 kilotonnes.

According to a classified Defence Intelligence Agency (DIA) report, there are several other pieces of evidence which, taken together, seem to support the view that the mystery flash was actually a bomb. The first of these was an acoustic signal recorded at a distant recording site in the Northern Hemisphere at an appropriate time after the flash, although some experts say no acoustic signal is normally expected for such a low-yield explosion. Hydroacoustic signals, a few decibels above background noise, were also recorded at two unidentified sites after 22 September.

A third piece of evidence was a traveling ionospheric disturbance (TID) observed by the Arecibo radiotelescope in Puerto Rico which was moving from southeast to the northwest and lasted several hours in the early morning of 22 September. This ripple in the ionosphere suggests that a shock wave moved through the upper atmosphere, displacing electrons as it moved along. The White House report maintains that all this evidence is circumstantial and may have been caused by various natural phenomenon, such as earthquakes, electrical storms, or solar flares.

Other pieces of the puzzle have been supplied by the CIA to congressional intelligence committees. One of these briefings described a task force of South African warships conducting a secret exercise at sea at roughly the same latitude and longitude where the flash appeared to occur in the atmosphere. Another scrap of evidence says that early warning radar stations operated by the Air Force picked up an electromagnetic pulse immediately after the 22 September event.

The CIA has told Congress that if the event was in fact a clandestine nuclear device then the two most likely candidates were South Africa or Israel, or perhaps both acting in cooperation. □

## Pay research hits government scientists

The government's 16 000 scientists are seething with indignation over this year's pay negotiations which have resulted in a management pay offer ranging from a respectable 22 per cent for some lowly grades to nothing at all for senior scientists. The scientists see this offer as part of continuing attempts by the Civil Service Department to undermine the status of scientists.

For the first time since the early 1970s, the scientific service, this year, has had its pay reviewed by the Pay Research Unit (PRU). This body finds "analogues" in outside industry for civil service jobs and compares pay. These comparisons then form the basis for negotiations between management and unions.

Although pay research, as this process is known, is relatively easy for the administrative, executive and clerical jobs, it has proved extremely complicated for scientists. Six grades of scientists are involved in the negotiations: Assistant Scientific Officer (ASO), Scientific Officer (SO), Higher Scientific Officer (HSO), Senior Scientific Officer (SSO), Principal Scientific Officer (PSO), and Senior Principal Scientific Officer (SPSO). The PRU board decided that there were satisfactory analogues for the three lower grades, ASO, SO and HSO. It also thought that there existed analogues for SPSO. However for the two middle grades—PSO and SSO—the PRU board also took into account the differences between pay for scientific and technical jobs in industry and compared these with the pay difference for these jobs in the civil service.

This complexity and the bias of the Civil Service Department and the PRU—both of which are staffed by administrative civil servants—have caused the difficulties in the current pay round. SPSOs, the most senior grade involved in the negotiations, have not been offered any pay increase for two reasons. First of all, the Civil Service Department wants to downgrade this job and to link it to the Senior Principal Administrative grade. Secondly, pay research did not produce very good evidence for this grade: the PRU could not find useful "analogues".

The "zero increase" offer for SPSOs has in its turn rubbed off on the two grades immediately below: at the top of their pay scales PSOs have been offered 6 per cent, and SSOs 9 per cent.

The complexity of these pay calculations also conspired with the PRU's staff

shortage to delay the settlement and minimise negotiating time. The Institution of Professional Civil Servants, the union involved, received the management's offer only three days before the deadline set by management. Civil service pay rises are implemented on 1 April.

Research on pay is normally done in sequence. For administrative grades pay research is normally completed late the previous year. Discussions then settle around February on what the pay research actually means. Then the union makes a claim and the management returns with an offer. Further negotiations, claims and offers then ensue. After the administrative grades, consideration of the professional grades follows. The scientists come last.

The first of the PRU's reports on the scientists 60 analogues started arriving in February; the last came around the end of April. Negotiations then began;



Will they revolt again? Government scientists have grown more militant in recent years

## Verdict on interferon still out

Promising results in a recent clinical trial of interferon point yet again to the controversial drug's potency against cancer. In the *Lancet*, 19 July, p 113, Dr T. J. Priestman reports that the tumours of two of 18 patients shrank after regular daily doses of interferon and in one case even the metastases (outposts of the disease in other parts of the body) began to disappear. However, the responses were shortlived: both patients died within two months after treatment was stopped. Nevertheless, Priestman concluded that "further trials are justified to define the extent of anticancer activity."

The British pharmaceutical firm Burroughs Wellcome sponsored the trial to test a particular type of interferon their laboratories aim to market commercially. Lymphoblastoid interferon is made from human lymphoblastoid cells—cancerous white blood cells with a capacity for indefinite growth outside the body.

Very little is known about how much the human body can tolerate of any of the interferon types, particularly lymphoblastoid, and the study set out to establish the maximum dose the patients could take of this very potent drug.

Researchers such as Thomas Merigan at Stanford University have scored suc-

cesses with breast and bone marrow cancers. Recent clinical trials have concentrated on these two diseases. The 18 patients in the Wellcome trial, however, suffered from 12 different cancers, located in the skin, uterus and stomach as well as those in the breast and bone marrow.

Half of the 18 received a range of single doses to test the maximum that could be tolerated. At the upper doses patients developed 'flu symptoms—high fever, dizziness, weakness and a fall in blood pressure.

Priestman next tackled the second stage of the study: daily treatment of the remaining nine patients for 30 days using a "safe dose below the upper one tolerated by the first group. He found that the patients soon developed a tolerance which permitted him to increase the daily amount.

Fever, a rise in blood pressure, and disturbances in blood cell manufacture by their bone marrow meant that only four patients completed their courses of treatment without interruption or a dose reduction before the 30 days were up. This does not offer much hope for advanced cancer patients who will require massive doses of the drug perhaps for the rest of their life to keep the disease at bay.

|      | The claim £ per cent | The offer £ per cent |
|------|----------------------|----------------------|
| SPSO | —                    | —                    |
| PSO  | 13.200               | 16.4                 |
| SSO  | 350                  | 9                    |
| HSO  | 8250                 | 23                   |
| SO   | 6775                 | 24                   |
| ASO  | 5300                 | 33                   |
|      | 15.748               | 0                    |
|      | 12.050               | 6                    |
|      | 9500                 | 9                    |
|      | 7900                 | 17                   |
|      | 6400                 | 17                   |
|      | 4925                 | 22                   |

Figures are for the maximum of each grade.

# This week

continued

## Genetic engineering down under

Brian Lee, Sydney, Australia

In a report released tomorrow the Australian Academy of Science follows recent moves in the United States (*New Scientist*, 26 June, p 374) by recommending that the laying down and policing of the nation's guidelines should pass to the federal government. The report stresses at considerable length the safety of recombinant DNA technology, while recommending that monitoring should continue to back up the shift in policy.

For the past five years the academy's Committee on Recombinant DNA Molecules (ASCORD), rather than the government, has laid down and administered the country's voluntary guidelines on recombinant DNA research—a regulatory role with which the independent academy has never felt entirely comfortable. Following the lead of the National Institutes of Health in America, ASCORD has been steadily relaxing its guidelines as the conjectured hazards of recombinant DNA have progressively evaporated. This development, and the fact that the technology is about to advance beyond the research phase, led the academy both to review its involvement with administering the recombinant DNA guidelines, and to start thinking ahead about what regulations should be on hand for controlling exploitation of the new technology by industry.

The academy's august Committee of Review—which includes Gordon Ada, a member of the prestigious and international Committee on Genetic Experimentation (COGENE)—is in a contradictory position. While it considers the

### Banking on watersheds

British engineers, water specialists and economists are leading one of the first comprehensive projects to assess the effects of generations of tree felling and overgrazing in the Himalayan foothills. The Punjabi government has selected two firms of consulting engineers—Sir William Halcrow and Sir Murdock Macdonald—to supply a team of seven experts for the Kandi Watershed and Area Development Project (KWAP), which starts this month.

The International Development Association, the branch of the World Bank that gives "soft" loans to the poorer developing countries, will probably spend \$30 million on the five-year project. The IDA's board of governors will consider the project at a meeting later this month. Their \$30 million will be matched by grants from the Punjabi government, as part of its strategy for raising agricultural production on the 4600 sq.km Kandi tract, which feeds 15 million people. If the project is successful, says Anne Hamilton of the World Bank, it could be a prototype for others in areas, such as Malaysia, which are afflicted by the same problems. □

risks from most recombinant DNA experiments to be less than those involved with everyday handling of disease-causing microorganisms in hospital pathology laboratories, it does not feel able to recommend the obvious conclusion—that central surveillance for most recombinant DNA experiments should be abandoned.

In practice, by recommending that the government take over ASCORD's surveillance functions, the committee may have burdened researchers wanting to use recombinant DNA techniques with more frustrating restrictions rather than fewer. It also recommends that two government committees be set up—one for overseeing the application of the new technology by industry, and a subcommittee for looking after research. Already the Federal Department of Science and the Environment has acted with what some researchers regard as indecent haste. It is rumoured that the department has already prepared a Cabinet submission proposing that it set up both committees.

Researchers, unhappy with the academy's recommendations, feel that they will be getting the worst of all worlds. ASCORD used to process their applications do do genetic engineering in about five weeks—a speed unlikely to be matched by the government bureaucracy. Moreover, the academy has

provided this service free, and at a very low cost to itself. Whereas, a figure of some \$80 000 of the taxpayers' money has been mentioned as the sum needed for operation of the government committees during the first year.

Another twist to the story is, that like GMAG in the UK (*New Scientist*, 17 July, p 181), ASCORD is likely to recommend that approval for experiments in its lowest containment category should in future come from the biosafety committee in the researchers' host institution. Because most recombinant DNA research applications fall into this category the new government surveillance committee may find itself with little to do.

It does not look as though the committee for monitoring the activities of industry will have too much to do either. While biotechnology companies in the United States and the UK may reap large profits from making insulin, interferon and other currently expensive substances, the Academy's Committee of Review expects that Australian firms will still be far behind. Consultation with the 25 local companies thought most likely to use recombinant DNA technology revealed that none expected to do so within the next few years. Isolation from the major markets for pharmaceutical products and the enormous cost of establishing facilities for developing recombinant DNA technology appear to be the major reasons for Australia not cashing in. □

### Toxic waste court cases pile up

The spectre of toxic chemical wastes is overtaking even nuclear power as the number one topic of environmental concern in the United States, and the government is acting accordingly. Last week for the first time, at the request of the Environmental Protection Agency, the Justice Department took a collection of major chemical companies to court in an effort to force them to clear up two chemical dumps in swampland sites in Louisiana. Among the companies named as defendants in the civil suit, alongside the owners of the dump, are the Dow Chemical Company, Exxon Corporation, American Hoechst Company and Shell Chemical Corporation.

Filing of the suit itself is not unusual. According to Barbara Blum of the EPA, it is the 30th filed as a result of hundreds of investigations of waste sites across the nation. What was unprecedented was the inclusion of the chemical companies that dump in the sites, together with the dump site owners.

The government is asking that the companies not only repair dikes and fence in the sites properly but also undertake the very expensive task of properly disposing of the wastes in accordance with EPA guidelines. The suit reveals that chlorinated hydrocarbons and heavy metals among other chemicals were released in dangerous quantities, killing many plants, trees, fish, alligators, turtles, cattle and birds. Officials estimate the cost of cleaning up the swampland and parts of the Mississippi River will run into millions of dollars.

The decision to file the suit marks the government's growing concern with the health effects of the hazardous sites, and the need to clean them up as fast as possible. "Here the injury is not merely imminent, it is already taking place," declared court papers filed by the Justice Department. "Every day humans and the environment are accumulating toxic chemicals and being subjected to ever higher risks of eventual death or injury from hazardous chemicals." □



A swampland resident under threat

John Wallis/Bruce Coleman

## Lead fun at the fair

Lead is the latest contestant to join the field of possible causes of the mystery illness that hit several hundred children recently at a carnival in Kirkby-in-Ashfield, in Nottinghamshire. On Monday the Health and Safety Executive told *New Scientist* that raised levels of lead had been detected in three grass samples from the field in which the carnival was held and from a nearby farm. Sensitive gas chromatography, linked with electron capture analytical techniques, picked up the lead, and highlighted three other "elements" that, as we go to press, are now being subjected

to further analytical tests.

Nearly 300 children needed hospital treatment and another 200 received first aid at the Kirkby carnival. The initial signs were that a number of children began to stagger and to collapse. The children, and some of their parents, complained of nausea, giddiness, sore eyes, coldness and a metallic taste in the mouth. Although all children were released from hospital in a day or so, during the following week a few showed recurring signs of the symptoms. At first these suggested organophosphate insecticide poisoning, but no residues of such materials were detected in the blood samples. Local farmers and the nearby Forestry Commission denied that they had sprayed any crops in the area with such materials recently. Public health authorities have also dismissed food poisoning as the cause.

The idea that mass hysteria was responsible has held sway on and off. But if this were the cause, the symptoms should have turned up predominantly

among girls—which they didn't. Without an underlying biological cause there seemed no way that some of the babies brought to the carnival could become embroiled in mass hysteria; a number of babies did in fact show the symptoms. Until a biological basis for the "domino" or mass hysteria effect turned up, the idea did not hold much water. Lead might provide an answer.

The lead occurs only in tiny quantities, measurable in parts per billion, and the fact that the field and the farm are in an essentially suburban setting is significant. The probability is that the lead stems from exhaust fumes, and may chemically be organo-lead originating from tetraethyl lead used widely as a petrol additive to prevent "knock" in engines. Although there is no direct evidence that the lead was responsible for the symptoms exhibited by the children, it could increase their susceptibility to stress. According to Professor D. Bryce Smith at Reading University, an expert in the physiological effects of lead, "it might just add credence to the concept of sympathetic hysteria." □

## Cancer cures rocket

Chemotherapy and other aggressive forms of treatment are rapidly improving the success rates of curing cancer. At present physicians are curing 41 per cent of all serious cancers, and within five years the proportion of cures will exceed 50 per cent. Those figures contrast with a success rate of just 34 per cent a quarter of a century ago. Such was the good news presented last week in Washington by Dr Vincent Devita, the man just appointed by President Carter to head the US National Cancer Institute.

Ironically, Devita identified the billion dollar "war on cancer" sparked by President Richard Nixon in the early 1970s as one of the causes of the rapidly increasing percentage of cancer cures. Critics inside and outside the scientific profession protested at the time, and have continued to argue since then, that the effort was directed too specifically at treating tumours. They claim not enough basic research on cell biology was done for the programme to be successful. However, Devita declared that calling the programme a failure was "quite wrong". But he added that the NCI would give greater attention to such research and particularly mapping the human DNA in the future.

Doctors have scored successes in a wide variety of cancers. Five-year remissions from breast cancer have improved from 63 per cent just under 20 years ago to better than 68 per cent today. For localised breast cancer, the comparative figures are 85 per cent now and 78 per cent about 30 years back.

Between the 1960s and 1970s five year survivals improved from 43 per cent to 49 per cent among colon cancer patients; from 38 to 45 per cent for people with rectal cancer; from 53 to 61 per cent for bladder cancer patients; from 50 to 63 per cent for sufferers of prostate cancer; and from 73 to 81 per cent for victims of cancer of the womb.

Even more encouraging, said Devita, is the fact that the present and promised improvements do not apply only to the five-year remission rate regarded as a benchmark for a cancer cure. They also indicate the restoration of patients' life expectancies to normal figures. □

The controversial motion for a complete moratorium on whaling once again failed to pass. Delegates at the 32nd meeting of the International Whaling Commission (IWC) in Brighton were clearly divided over the issue: 13 voted for the motion and nine against, with two abstentions. But the vote fell five short of the required three quarters majority needed to pass the motion.

Earlier in the week, Gerry Wiggin, parliamentary secretary at the Ministry of Agriculture, Fisheries and Food, reaffirmed the UK government's desire to put an end to all commercial whaling. Wiggin drew attention to inhumane methods of killing whales. Commercial whalers are increasingly using the "cold-grenade" harpoon, which allows whales a lingering death, in preference to the explosive harpoon which, while it dispatches whales quickly, can damage part of the meat. "We consider the 'cold-grenade harpoon' to be a particularly inhumane method and we will therefore support a ban on its use in all commercial applications," Wiggin said.

Fears that Taiwan would precipitate a political storm were avoided by postponing a decision on its application to join the IWC. Taiwan recently took up whaling on behalf of Japan, using equipment financed and manned by Japanese and exported its catch to Japan after "laundering" in South Korea. It would obviously help the whaling nations if Taiwan were a member of the IWC, but of the 24 members only 2, South Korea and South Africa, recognise Taiwan.

Subsistence and aboriginal whaling is the other main issue for discussion at this week's meeting. Dr Lyall Watson, best-selling author and IWC delegate for the Seychelles, got the meeting off to a confused start when he suggested

## Harpooning

## the whalers



Frozen whale meat for Japan

bringing aboriginal whaling forward on the agenda so that it could be decided before the moratorium discussions.

Aboriginal whaling is a particular problem for the US because Inupiat Eskimos, (who are Alaskan citizens) hunt bowhead whales, the most endangered species of whale. Not only has this issue caused some dissent among environmentalists in the US, who were torn between preserving whales and the lifestyle of the Eskimos, but last year the US was accused of trading its support on catch quotas in exchange for a quota for the bowhead. The Seychelles hopes that if the aboriginal issue has been decided the UN will then be free to push for a moratorium.

Japan objected to the change in the agenda but was outvoted and the IWC went into private session to discuss first aboriginal whaling and then the proposed moratorium. In those discussions the technical committee of the IWC rejected the US's claim for an unchanged bowhead quota but voted in favour of a worldwide ban on commercial whaling. However the vote—14 to 9 for a ban with Norway abstaining—was not enough to pass in the open meeting, so the bargaining got under way seriously. □

# This week

continued

## Industry and academe shake hands on robots

Britain's Science Research Council (SRC) is making available £2.5 million over the next five years to aid the development of robots. It wants the money to be spent particularly on research into "intelligent" robots—these machines are flexible arms, controlled by computers, that have sensors to let them decide what is happening nearby and react accordingly. The SRC says its plan should let Britain "leap frog" the current generation of "unintelligent" robots which do not have sensors: these devices repeat the same operations oblivious of changes in their working conditions.

Intelligent robots constitute a very small proportion of the world's 10,000 robots (of which Britain's share is about 200). They are particularly applicable to assembly operations where, for instance, a robot hand has to pick up parts that travel toward it, orientated in a number of different ways, on a conveyor. Ordinary robots, unlike the new breed of

machines, cannot distinguish between the different orientations. So they are useless, unless the parts are presented to the robot in the same way.

The SRC plans that much of the £2.5 million will be spent on joint ventures between academe and industry. As a rough guide, industry should contribute £1 for every £4 that the SRC spends. Peter Davey, the council's robots co-ordinator, says that his proposal has generated a lot of interest among firms anxious to develop robots or to put them to work in their own factories.

So far the SRC has agreed to spend £425,000 of the new cash, most of which will have to come from other parts of the SRC's budget (as the council's total spending has not increased). GEC is involved in two projects: it will cooperate with the University of Hull and the University of Edinburgh in studies which will develop robots with elementary sight. □



## California condor chick dies

Scientists attached to the University of Washington and the Department of Health, Education and Welfare (HEW) in Seattle, are close to perfecting a vaccine against the 6000 strains of gonorrhoea that annually infect more than a million American victims. Three years ago, gonorrhoea was listed in the United States as one of the major infectious diseases for which no vaccine had been developed. The problem of control was complicated by the fact that bacterial resistance to penicillin treatment was rising. Health officials handling federal and private purse strings were all the more frustrated by the amount of money spent on curing the disease: upwards of \$300 million annually.

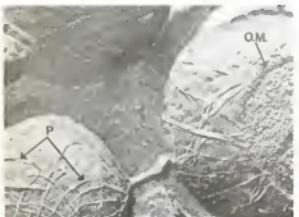
According to Duane Olsen, a research technologist working with Dr Tom Buchanan, who has already spent five years working on gonorrhoea at the University of Washington, the route of infection is through the mucous membranes of cells lining the sex organs. Once in contact with mucosal cells, the bacterium *Neisseria gonorrhoea* extends fibres or pili from its outer membrane to

the host cell's surface. Now securely attached, the bacterium multiplies. After penetrating the mucosal barrier of the host, the bacterium freely enters the blood and travels to infect the skin, heart and joints. In some cases gonorrhoea can even cause the birth of blind babies and sterility in women. However once blood-born, the pili are lost, and the only protection the bacterium has is its outer membrane.

Olsen and Buchanan have been working on a vaccine that would combat the bacterium in either of the two most effective places: the portal of entry—the mucosal membranes—or the blood stream. The "pili" vaccine is being developed to prevent the attachment of the bacterial pili to human cells. This vaccine would be most effective against local infections—about 90 per cent of all gonorrhoea cases.

The second or "POMP" (principal outer membrane protein) vaccine will launch an attack on the bacterium itself by stimulating the body to produce antibodies. These coat the bacteria and enhance the defensive mopping up by the body's white blood cells. POMP will be effective against gonorrhoea which has spread throughout the body after the local disease went untreated.

Already, vaccine trials have taken place with human volunteers. Six groups have been vaccinated: three with the pili vaccine and three with the POMP. So far, Olsen and Buchanan have detected antibodies in the blood over a period of seven weeks and tests are now under way using alum phosphate to promote the life of the antibodies to at least six months. Olsen expects that the next stage of testing—"challenge" trials where volunteers will be vaccinated and challenged with a strain of *N. gonorrhoea*—will take place within the next two years. □



A close look at the gonorrhoea culprit with split outer membrane (om) and its pili (p)

The case of the vanishing California condor has taken a sudden, tragic turn. Researchers from the US Fish and Wildlife Service and the National Audubon Society recently received permission to capture as many as possible of the 20 to 30 remaining condors and attach radio-transmitter collars to them, despite protests that the handling could harm the birds. (New Scientist, 26 June p 377). But a two-month old, 6 kg chick that was being weighed and measured died in the hands of the scientists.

Experts knew only of two nesting California condors this season—the other was handled without any trouble—so the loss is a grave one. And while no one can say positively that the chick died of fright, the Fish and Game Commission in California state has rescinded permits for the radio telemetry programme. The commission will hold a hearing on the whole affair next week (1 August), which could lead to the cancellation or long-term postponement of the whole project. □



Under the heavy blackness of a Nigerian evening a dozen Africans are peering through a hedge. Their faces are alight with excitement. They watch in astonished silence. Beyond the hedge is the verandah of a private house and on the verandah a ghost-white image of a television screen. A mile away in a busy thoroughfare African boys sit in clusters under the street lamps. They are studying for a School Certificate. They have to do their homework in the street, for there is no light at home except a candle in the corner of the room. These scenes epitomize the impact of the electrical industry on civilisation.

The New Scientist, 28 July, 1960

# More of our financial resources could be used to save our natural ones.

This is one of a series of advertisements designed to increase public awareness of the position of the railways in the national transport system and also to highlight the role of the railways. While the facts and figures contained in these advertisements are known and appreciated by those directly concerned in shaping the future, an industry as much in the lime-light as ours has a duty to address itself to a wider audience, which needs to be well informed if it is to play its part in helping to form public opinion.



## A POWERFUL CASE FOR ELECTRIFYING THE RAILWAY

Electrification offers the best hedge against any future energy shortages because it enables the railways to derive power from a number of basic fuels.

Oil will become increasingly scarce, and ever more expensive, so the capability of the railway to draw its energy needs from alternative sources is potentially important for the national economy.

Increased electrification would significantly decrease the railway's demand for oil. For instance, if 5,800 miles of British Rail's total 11,000-mile network were electrified (the largest of five options currently under consideration) we would save 120 million gallons of diesel oil per year.

Not only would electrification help to reduce our national dependence on oil:-

## LOWER COSTS; GREATER RELIABILITY.

Electric locomotives are simpler, lighter, cheaper and longer-lasting than equivalent diesels.

They have a higher availability for service, since they require no time for refuelling and substantially less for maintenance.

Also, electric traction is demonstrably more reliable than diesel - technical defects (hence delays) occur one-third as often.

And electric systems are able to offer faster and more frequent service. Obviously, that has important implications for more flexible policies on fares and charges. Moreover, in the long-term, electrification will increase the prosperity of the

engineering industry and reinforce the export potential.

## THE EUROPEAN COMPARISON

As we've seen, electrification can make a major contribution to oil and energy conservation, to better service and lower operating costs.

Yet, of the nine EEC countries, Britain has less railway electrification than all members except Denmark and Ireland. The average electrified mileage of railways in the EEC is just over 35%, compared with 21% for Britain.

## THE COST

The cost of electrification for Britain is not unreasonable. Although the *initial* investment outlay is

high, the savings and increased revenue generated from wide-scale electrification would undoubtedly cover the cost in the long-run. Extra funds will be required in the short-term, but they will not be wasted.

## 2000, AND BEYOND

If we start now, we can provide a railway system which will enable our successors to run an economic transport system in the year 2000 and beyond.

However, the later the start, the more the system will cost; inflation hampers the railways as much as any other sector.

Furthermore, the existing diesel fleet has a limited life and it will be a difficult and costly task to bridge any gap between the demise of the existing fleet and readiness of the new electrified network. Thus, the more energy and resources we spend towards achieving large-scale electrification now, the more we'll save in the end.



**This is the age of the train**



Photographs by Pete Addis



Laurence Godfrey  
is a freelance writer

## A shopper's guide

Nuclear war and private enterprise are strangling  
Britain's most rapid

The events in Iran and Afghanistan have given birth to a new industry: more than 300 companies in Britain are now involved in making shelters, filters, protective clothing and the other paraphernalia of nuclear protection. The government is reviewing civil defence arrangements—for the first time since the Wilson government reorganised civil defence in 1968—and has asked a Home Office working party to produce plans for private shelters. These are unlikely to be available before the end of the year. Meanwhile, Home Office planners and scientists are besieged with requests for advice, and many people—some willing to pay up to £30 000 for a shelter—are turning to the new breed of nuclear entrepreneurs.

Unfortunately, this new breed includes few experts, and prospective buyers should bear in mind the ancient common law rule of *caveat emptor*. If a bomb shelter is ever put to the test and proves to be defective, the aggrieved party is unlikely to be able to resort to consumer legislation. With luck, though, there is still time to shop around.

A good nuclear shelter must protect against thermal radiation, nuclear radiation and mechanical stresses: a bomb will produce both a blast in the air and shock through the ground. The whole shelter should be underground to increase its blast resistance and to take advantage of the soil's ability to attenuate radiation.

The best material for shelters is steel-reinforced concrete. A shelter's resistance to heat and nuclear radiation depends only on the thickness of the concrete, while its ability to withstand mechanical stresses depends both on the concrete thickness and the quantity of steel reinforcement. A shelter is only as strong as its weakest point: concrete structures are usually cuboidal, so the corners and edges must be reinforced with special care.

A reinforced concrete shelter must be built *in situ*; but pre-fabricated shelters of glass reinforced plastic (glass-fibre), steel and lightweight concrete are also on sale. They are cheap and simple and their effectiveness does not depend on the competence of a local builder; but few pre-fabricated models can compete with a properly constructed reinforced concrete shelter.

A sheet of glassfibre 1.5 cm thick offers little protection from radiation but it can resist surprisingly high pressures; it is suitable for shelters provided they are underground. But the ability of a glassfibre shelter to withstand mechanical stresses depends crucially on its shape and on how carefully it is manufactured. Large flat surfaces, edges, corners and joins between panels are weak points: the ideal shape is spherical but as this is somewhat impractical, shapes which approximate to a sphere are

*Top left* Terry and Richard Deal of Universal Protection (Essex) Ltd in their prototype reinforced "Nusafe Shelter" which is designed for 10 people and costs around £15 000. The Nusafe is built to Swiss specifications: the Deal brothers call it a "Rolls-Royce shelter" and claim it has a protective factor (PF) "in excess of 2000" and withstands a blast of three atmospheres.

*Tom Butler's shelter* (on the cover and contents page) has a PF greater than 2000 and resists one atmosphere overpressure

*Left* Sean Owen runs Nuclear Attack, Protection, and Safety, at Leigh-on-Sea in Essex. He also deals in gemstones. His prefabricated concrete shelter costs about £4000 (plus installation) and holds four people. Mr Owen claims that its 10 cm thick walls can withstand a blast of one atmosphere. The PF is as yet unspecified

# o nuclear survival

fellows. But the survival business is one of expanding industries . . .

the next best thing. The mechanical stresses following a nuclear detonation could push a light shelter out of the ground, the better glassfibre shelters have a concrete slab over the roof to keep them down. The slab also increases the blast resistance and makes them easier to install when the water table is high; otherwise they tend to float.

The Home Office is particularly interested in private glassfibre shelters, which offer a relatively cheap and practicable alternative to concrete. Steel has fewer advantages—it costs a lot to provide a high resistance to blast. Although several cheap steel shelters are available, one manufacturer has not been able to provide a blast pressure specification, while another firm's shelter, consisting of a light steel framework covered by a plastic coated steel mesh, has no floor and no effective means of preventing the internal pressure from rising to a level that could injure the people inside.

The Swiss and Swedish governments, both of which have comprehensive civilian shelter programmes, have opted for the well-tried reinforced concrete structures. In Britain these cost around £1500 per head for a family sized unit; the larger the shelter, the lower the cost per head. Prefabricated shelters begin at around £500 per head and there are several less effective varieties of shelter available at lower cost.

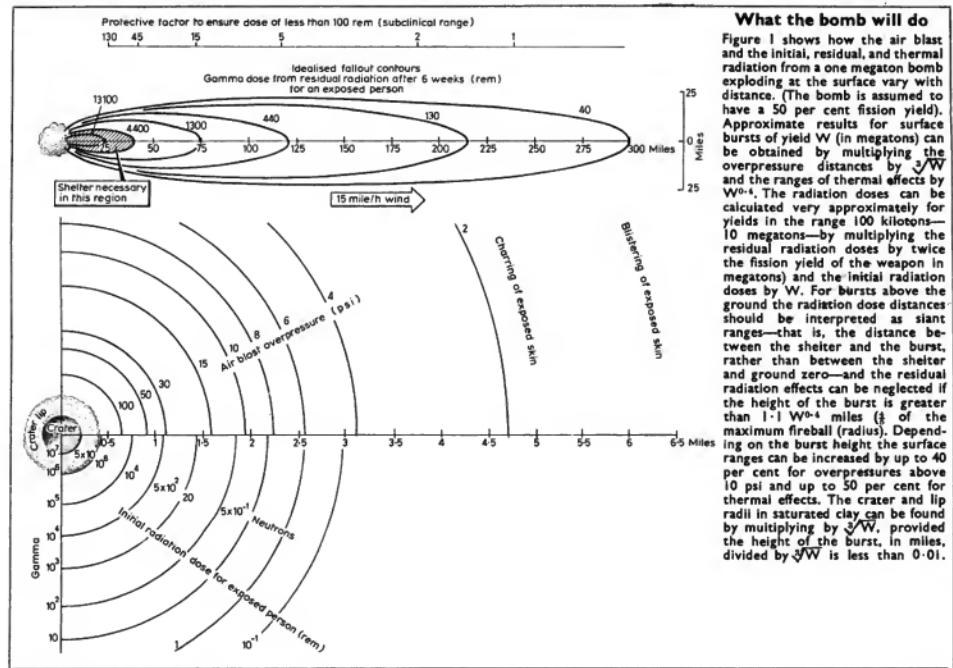
A shelter must protect its occupants from two categories of nuclear radiation: the initial radiation, mainly gamma rays and neutrons, which is emitted from the fireball and remains a hazard for up to a minute after detonation; and the residual radiation, mainly gamma rays and beta particles, which persists at harmful levels for many weeks. The residual radiation comes from fallout particles on the ground surface which have been bombarded by neutrons.

It is difficult to calculate the extent to which a shelter can attenuate the initial radiation because of the very wide spectrum of neutron energies. However, unless a shelter is very close to the detonation, the neutron flux is less significant than the initial burst of gamma radiation. Concrete and soil provide fairly good protection against "gammas" and neutrons so the best compromise is to use enough of these materials to reduce the gamma-radiation intensity to a safe level.

Although the initial gammas have a higher average energy than the residual gammas, protection against the residual radiation is the most important consideration, except with low-yield weapons. If the shelter is far enough from a megaton detonation to survive a blast, the residual gamma radiation gives rise to considerably higher doses than the initial radiation. The thickness of material, in centimetres, required to halve the intensity of initial gamma radiation—the half-value thickness—can be roughly calculated by a rule-of-thumb: 33 divided by the density of the material in grams per cubic centimetre (so the figure for water, for example, is about 33 cm). For residual gammas the half value thickness is given by 13 divided by the density.

*George Elliott (top right) of D&P Hastings Ltd of Bromsgrove, Worcs, emerges from his ellipsoidal glassfibre "armour" shelter (right), which is designed to house six people and costs £2500 plus installation. Mr Elliott also manufactures bodies for armoured vehicles and works under contract to the Ministry of Defence. He claims that his shelter's 13 mm thick walls can withstand a blast of three atmospheres and offer a PF greater than 100 when covered by at least 2 ft of soil*





A shelter's ability to protect its inhabitants from radiation can be estimated by calculating its protective factor, or PF. This is the factor by which the residual radiation dose inside a shelter differs from that of an exposed person above ground. The Home Office estimates that the PF of a makeshift shelter, constructed inside the home according to government recommendations, would be about 50, so the occupants may be consoled by the thought that they are exposed to one-fiftieth of the dose of anyone unfortunate enough to be caught in the open.

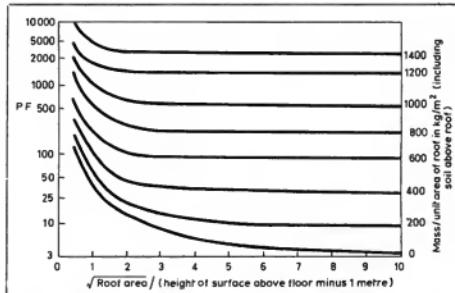
The government's booklet *Nuclear Weapons* shows how to calculate the PF of a shelter; the graphs in Figure 2 give a rough estimate, provided that the simplifications explained in the graph apply to the particular shelter. It is unwise to accept shelter firms' claims for PF, as these seem to be subject to very large errors. One shelter manufacturer had underestimated by a factor of at least 10 and another claimed that tests had proved that his concrete was five times more effective than ordinary concrete against gamma radiation whereas they had actually proved it was only half as good.

The residual radiation arises from more than 200 radioactive isotopes and so has no unique half-life, but an approximate rule will help you to calculate the radiation dose rate from the mixture for several weeks after an attack; the activity falls by a factor of 10 for every seven-fold increase in time. The infinity dose—the theoretical dose that would be absorbed in an infinite amount of time from fallout—is approximately twice the dose accumulated in the first hour. The unit of absorbed radiation dose, which takes account of the effect on living tissue, is the roentgen equivalent man (rem), and the lethal dose for 50 per cent of the population (that is, the LD 50) is about

## What the bomb will do

Figure 1 shows how the air blast and the initial, residual, and thermal radiation from a one megaton bomb exploding at the surface vary with distance. (The bomb is assumed to have a 50 per cent fission yield). Approximate results for surface bursts of yield  $W$  (in megatons) can be obtained by multiplying the overpressure distances by  $\sqrt[3]{W}$  and the ranges of thermal effects by  $W^{1/4}$ . The radiation doses can be calculated very approximately for yields in the range 100 kilotonnes—10 megatons—by multiplying the residual radiation doses by twice the fission yield of the weapon in megatons) and the initial radiation doses by  $W$ . For bursts above the ground the radiation dose distances should be interpreted as slant ranges—that is, the distance between the shelter and the burst, rather than between the shelter and ground zero—and the residual radiation effects can be neglected if the height of the burst is greater than  $1.1 W^{1/4}$  miles ( $\frac{1}{2}$  of the maximum fireball radius). Depending on the burst height the surface ranges can be increased by up to 40 per cent for overpressures above 10 psi and up to 50 per cent for thermal effects. The crater and lip radii in saturated clay can be found by multiplying by  $\sqrt[3]{W}$ , provided the height of the burst, in miles, divided by  $\sqrt[3]{W}$  is less than 0.01.

400 rem. Three miles from a 5 megaton surface burst an exposed person would accumulate a dose of less than 1 rem from the initial radiation, but someone standing as far as 200 miles away could, one hour later, be subjected to a dose of 100 rem/hour from residual gammas. Someone



## How to calculate a shelter's protective factor

Figure 2 shows how to evaluate the radiological protective factor—PF—of an underground shelter. The curves are based on four assumptions: that the shelter has a flat roof of uniform thickness; that the ground above it is unshielded; that except for ventilation apertures of negligible area, all the walls are in contact with the soil; and that entries in the roof are covered by material that has at least as much mass per unit area as the roof itself. (If these assumptions are not applicable, refer instead to the tables in *Nuclear Weapons* HMSO, London, 1975).

The mass per unit area in  $\text{kg/m}^2$  for 1 cm thickness of some typical materials is as follows: steel—78; lead—114; concrete—23; brick—19; earth—16; wood—5.

about 30 miles from the detonation inside a shelter with a PF of 50 could accumulate a fatal dose of residual gamma radiation within one day; yet if the shelter had a PF of 1000 the total dose accumulated within six weeks would not exceed 25 rem.

A shelter's ability to survive a nearby burst depends on the "overpressure" it is designed to withstand. A good shelter can withstand all the effects of a detonation close enough to raise air pressure outside to about one atmosphere above normal (an overpressure of 15 psi). Such a shelter would protect its occupants if no closer than 2.3 miles from ground zero for a one megaton burst, or 4.9 miles for 10 megatons. The best Swiss shelters are built to withstand an overpressure of three atmospheres, which corresponds to distances of 1 mile for one megaton and 2.2 miles for a 10 megaton bomb. Some shelter builders claim their products would survive closer explosions than these—they prefer to overlook the longer-range effects of airbursts and consider only ground-bursts. The radius of any particular overpressure reaches a maximum at a particular height of detonation; Figure 3 shows these maximum radii of different overpressures for a one megaton bomb.

The overpressure specification of some of the shelters on the market must be taken with several pinches of salt. It is impossible to know exactly how a shelter would behave in an attack without testing it by letting off conventional explosives. However, a good designer ought to be able to calculate an approximate specification for a shelter, preferably one which includes a safety factor of two or three; but some designers have just guessed at their shelter's resistance to blast while one has rated the shelter by basing its specification on the pressure that can be withstood by only one component: the door.

The size of the blast and the intensity of radiation are not directly linked; smaller weapons produce a higher initial radiation intensity at a given overpressure, than larger ones. The Swiss have taken the worst possible case and developed a set of standards based on the requirement that the initial gamma exposure dose from a 10 kilotonne ground-burst should not exceed 100 roentgens (equivalent to a biologically effective dose of 100 rem) inside a shelter at the minimum distance from the burst



The octodecagonal shelter (above and below), marketed by Designs for Defence of Twickenham, Middlesex, has 18 mm walls made from plywood sandwiched between glass reinforced plastic. It holds four to five people and costs about £6000 including fittings, though the final cost will depend on the site of installation. One of the designers, John Horgan is a civil engineer. He claims the shelter can withstand a blast of at least 12psi (4/5 atmospheres) and has a PF of 2-3000 when covered by at least 3 ft of soil

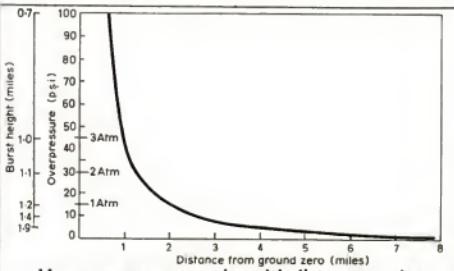


Figure 3: The overpressure produced at ground level, for any given size of bomb, depends upon the height of the burst above ground. In addition, at any given height, the radius of one particular overpressure contour is maximised. In the graph, the ordinate shows the height of detonation at which any particular overpressure would have its maximum range; and the abscissa shows that range at ground level. For instance, the graph shows that if a one megaton bomb explodes at a height of 1.1 miles, the two atmosphere overpressure extends to its maximum radius—and this radius is about 1.25 miles.

This graph refers only to a one megaton bomb. To calculate the corresponding distances from ground-zero for yields other than 1 megaton, the distances should be multiplied by the cube root of the weapon yield in megatons.



Neil Hart is director of Abacraft, Basildon, Essex; his glassfibre shelter (left) is reinforced with timber. It is designed to hold six people and costs about £7000. Mr Hart, who also supplies double glazing, claims that his shelter will withstand a blast of three atmospheres and has a PF greater than 1000. It is fitted with a Swedish purpose-built forced ventilation system with filter (above), which could supply air for about 50 people

at which it could withstand the blast. This ensures that the PF of their shelters is well above 1000.

Swiss one-atmosphere underground shelters must have a concrete roof at least 30 cm thick with a soil covering of 50 cm, but the roof must be 55 cm thick if its top is level with the ground. Walls must be at least 25 cm thick and the floor no less than 20 cm. If there is a building above the shelter the roof can be thinner. The corresponding figures for "three-atmosphere" shelters (those that can withstand an overpressure of three atmospheres) are 50 cm for a roof covered by the same thickness of soil and 85 cm without soil cover. The floor thickness must be increased to 25 cm but the wall thicknesses remain the same, provided all the walls are entirely in contact with the soil. The roof thickness can be reduced by about 10 cm for every 15 cm of soil above it, without altering the PF, but the structure must remain strong enough to withstand the mechanical stresses. The Swiss require minimum roof thicknesses of 20 cm for one atmosphere shelters and 35 cm for three atmosphere shelters.

For structures made of materials which ignite, melt or degrade at relatively low temperatures—such as glassfibre—thermal radiation may be important. If the shelter is some feet below ground—as it should be for radiological protection—and if exposed apertures are sealed by non-combustible materials with high melting temperatures, it should prove adequate. But at least one shelter on sale does not satisfy these criteria; thermal radiation may weaken its exposed glassfibre hatches so that it is no longer able to withstand the blast.

Calculations of the PF of a shelter assume there are no sources of radiation inside; ideally, the ventilation system should incorporate a filter to keep out airborne particles of fallout. Swiss and Swedish manufacturers can supply a purpose-built manual ventilation system of this type, for at least £400. Most shelter firms provide one.

However, there is considerable confusion about filters: several designers believe that filters can actually extract the radiation from fallout. But the purpose of filters is to stop fallout particles getting into the shelter; they do not stop these particles from emitting radiation. The dust they trap remains radioactive, so the filter itself may become



a radiation hazard unless it is adequately shielded or some distance from the occupants.

The most harmful fallout particles are fairly large—mostly between the size of a marble and of a small grain of sand—and descend within 24 hours. They can be prevented from entering fairly easily by an air inlet pipe with many bends. Smaller, microscopic particles which descend over a period of years emit only a little radiation by the time they reach the surface but, they can be a long-term hazard when swallowed or inhaled. Filters and respirators will trap such particles although only those with a diameter less than about 10 micrometres will pass through the nasal passages, and most of these descend many days after an attack. Filters will keep out smoke from burning buildings and give considerable protection against chemical and biological weapons. Although a filter is not essential, some means of forced ventilation must be provided to change the air inside the shelter. Whatever system is used, it must withstand the initial blast, and, if it is electric, it must not rely on mains electricity.

You can always supplement a shelter with protective clothing. An NBC (nuclear, biological and chemical) outfit with a respirator, which British soldiers call a Noddy suit, costs £95 to £180. These suits cannot protect people against gamma radiation, however. They will considerably reduce radiation by beta particles—but then so will most normal clothing. Noddy suits can prevent flash (heat) injuries during an explosion, but buildings give much better protection so anyone with enough warning to don a suit should run for cover. In practice, suits may prove to be dangerous, as wearers might wrongly believe they can safely leave cover soon after an attack. However, NBC suits can protect people from chemical and biological weapons—and, although the government feels that these weapons are not likely to be used against civilians on a large scale, the cautious individual (who by now may feel considerably more vulnerable) might prefer not to take the risk.

Even if you do feel that a shelter and/or a suit are worthwhile investments, one thing is clear: private shelters are too expensive for everyone. If there is a war, most people will have to rely on whatever public protection the government can provide. □

# Automatic cars can save petrol

The manual gearbox used in most British cars is 10 per cent more efficient than the automatic in most American ones. But it still absorbs 20 per cent more fuel than it needs to. Now engineers are putting the finishing touches to novel automatics that can cut petrol consumption by over 20 per cent

**Anthony Curtis**  
is editor of *Motor*

If you drive a small car like a Volkswagen Polo hard, you will do around 35 miles per gallon if it

has a manual gearbox and 10 per cent less if it is an automatic. Within a few years, with new kinds of automatic gearboxes being developed, your hard-driven car will be doing 42 miles/gal and more than 50 miles/gal if you treat it gently. The new gearbox will save fuel by matching the power of the engine to what you want the car to do—at all times.

But the present day manual gearbox should not be dismissed as being a fuel waster. It is in fact about 90 per cent efficient, and the conventional automatic is about 80 per cent efficient. But the weakness of both types is that they provide a poor match between what the driver wants and how the engine must be controlled to run at its best. This is because the internal combustion engine is very inefficient when it is delivering less than its full power for any engine speed. This is partly because the friction within an engine is proportional to rotational speed and is virtually independent of the power being developed. For this reason alone, therefore, the larger the throttle opening and the lower the engine speed the greater is the efficiency.

But the efficiency of the petrol engine tends to fall when it is lightly loaded, for another reason—that the power it produces is controlled by varying the opening of the throttle valve which regulates the amount of both fuel and air admitted. When this throttle valve is less than half open, it creates large "pumping losses" simply because it obstructs the airflow into the engine. (The more efficient diesel engine, on the other hand, has no throttle and is free to draw in as much air as it likes, its power being controlled merely by regulating the fuel supply.)

In combination, the pumping and frictional losses reduce the specific fuel consumption of a petrol engine when its throttle is less than half open (Figure 1). Unfortunately, today's dense traffic means that the "throttle openings" for most of a car's running time are small. The engine is rarely called on to develop much of its power—a high proportion of what is available is needed only when accelerating hard or when cruising at high speed.

All this follows from the way in which the engine is required to deliver that power. Consider, for instance, the fuel consumption in gallons per hour of a typical modern engine plotted against power output and engine speed (Figure 2). This particular engine will develop just over 10 brake horsepower (bhp) at around 1500 revs per minute with its throttle fully open. But with the throttle partly open it will also develop 10 bhp at around 3200 revs/min and again at about 4500 revs/min on a still smaller throttle opening. The fuel consumption figures for these three conditions are 0.8 gal/h, 1 gal/h and 1.3 gal/h respectively.

In a typical small car, top gear gives about 15 mile/h of road speed to each 1000 revs/min of engine speed.

So at 40 mile/h—about the steady speed which 10 bhp will give on the level—the engine will be running at around 2700 revs/min, much nearer to the wasteful 1 gal/h regime than to the optimum rate of 0.8 gal/h. One obvious way of improving the fuel consumption, therefore, is simply to raise the car's gearing, to make the overall ratio numerically smaller so that the road speed/engine speed relationship in top is, say, 20 mile/h per 1000 revs/min instead of 15 mile/h. But cars do need some surplus power—to climb hills, to overtake safely and so on—so there is a limit to the amount by which the gearing can be raised.

These conflicting needs can be reconciled by an advanced fuel saving transmission. Ideally, such a transmission must:

- Have a ratio range of 6:1 or 8:1 rather than the 4:1 typical of most current three-speed or four-speed transmissions (from 4:1 in bottom to 1:1 in top), manual or automatic.
- Be fully automatic, with an electronic control system programmed to keep the fuel consumption to a minimum for every combination of speed and load.
- Incorporate some sort of coupling system so that the engine can continue running when the car is at a standstill. This last requirement is met by existing conventional automatic transmissions, so why not adapt them to give the low fuel consumption envisaged? The answer is that conventional automatic transmissions incorporate a form of coupling (called the hydrokinetic torque converter) that was chosen because it was reliable and convenient rather than efficient. This device is literally one that uses fluid to produce motion and is, strictly, a torque multiplying device.

In a torque converter an engine-driven vaned wheel (an impeller) flings hydraulic fluid across a small gap and into another vaned wheel (a turbine), so driving the gearbox. The engine's torque is multiplied as well as transmitted, when the impeller rotates faster than the turbine by interposing a "stator" between them. The vanes are curved in such a way that when the impeller is rotating faster than the turbine, the angled flow of hydraulic fluid from the turbine passes through the stator. This gives the fluid a degree of angular velocity, so that after passing through the impeller it picks up speed and consequently transfers more torque to the turbine. Multiplication of torque takes place mainly when the car is accelerating but when it is running at cruising speed—when the turbine speed rises to more than about 90 per cent of the impeller speed—the converter begins to act as a pure fluid coupling.

Although the torque converter is 95-98 per cent

efficient when the car is at cruising speed, it is far less efficient when multiplying the torque (Figure 3). It is this inefficiency which is largely responsible for the fuel consumption penalty of around 10 per cent generally associated with automatic gearboxes compared with manual ones.

So the engineer, faced with that cul-de-sac, must explore other avenues. One approach is the experimental five-speed gearbox



British Leyland's energy conservation car (ECV2) will sport a continuously variable transmission. This, plus other factors, give it a fuel consumption of 60 miles per gallon at 60 miles/h

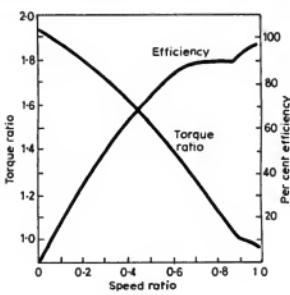
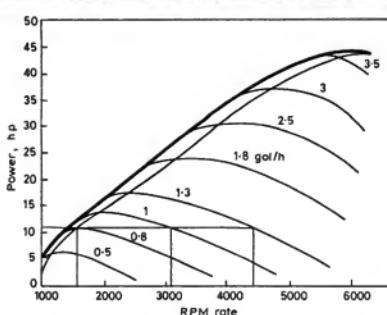
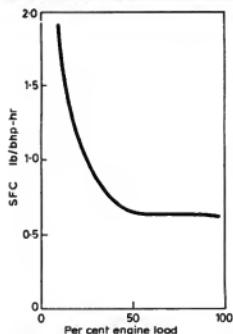


Figure 1 (left). The specific fuel consumption of petrol engines running at less than 50 per cent load is poor. Figure 2 (centre). Efficiency is proportional to throttle opening and inversely proportional to engine speed. Figure 3 (right). How a torque converter delivers the goods; efficiency is highest when the impeller/turbine speed ratio is highest

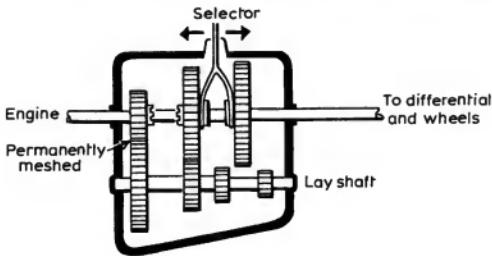


Figure 4 How a typical manual gearbox works; one layshaft transfers the drive from engine to wheels

that Fiat built some years ago which used ordinary gears rather than the epicyclic arrangements (Sun and planet gears) that are generally used in automatic transmissions. It works in the same general way as a conventional constant-mesh manual gearbox. But it has two "layshafts" (shafts in addition to those providing the input and output to the gearbox) instead of just one and uses hydraulic clutches to permit fully automatic operation. A centrifugal clutch decouples the engine from the gearbox when the car is at a standstill. In dynamometer tests, related to the US's urban driving cycle, a car fitted with the unit used 17 per cent less fuel than when it was fitted with a conventional manual gearbox.

The Automotive Products Company of Britain has adopted a similar concept in its experimental automatic transmission system. This provides fully automatic operation but without significant energy losses and in a suitably developed form could also give large fuel savings. Like the Fiat transmission, the AP system is based on a conventional manual gearbox, but it has four-speeds and uses sliding synchromesh clutches. It has two input shafts (Figure 7), one driving first, third and reverse through an ordinary single-plate clutch and the other driving second and fourth gears through a smaller (because it is more lightly loaded) oil-immersed clutch. A hydraulic pump, absorbing a tiny amount of power, drives the various hydraulic rams required, and the control is electronic.

At rest, the primary clutch is automatically disengaged. When the driver puts his foot on the accelerator to move off, a hydraulic actuator selects first gear and the clutch

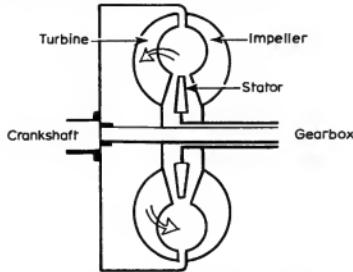


Figure 5 A torque converter multiplies the engine's torque but adds to its losses

is progressively engaged hydraulically (it remains to be seen whether in production versions the take-up would be acceptably smooth and the life of the clutch adequate). As the car goes faster the secondary clutch disengages to allow second gear to be selected, then the secondary clutch re-engages as the primary clutch disengages to provide a smooth change under power. The other gear changes are made in a similar way.

One advantage of this concept is that manufacturers can use it to modify ordinary gearboxes relatively cheaply. American car makers have not been slow to appreciate that it provides a way of conforming with future fuel consumption legislation using basically standard automatic gearboxes. AP claims that tests it has done show that an advanced version, the same length overall as a four-speed gearbox, with six ratios giving a 10:1 ratio range, can give fuel savings of up to 25 per cent.

But these automatic transmissions change their ratios in steps. There is obviously an advantage in changing them continuously so as to keep the engine precisely at the speeds which give the minimum fuel consumption for the prevailing road speeds and throttle positions. The device that can do this is the continuously-variable transmission.

A continuously-variable automatic transmission has been commercially available, however, for cars for many years. Originally called the Daf Variomatic system, it is now known as the CVT since Dutch company Daf was taken over by Volvo. It consists of a belt drive, the pulleys of which can be expanded and contracted in diameter to alter the ratio between them. But it is bulky and cumbersome.

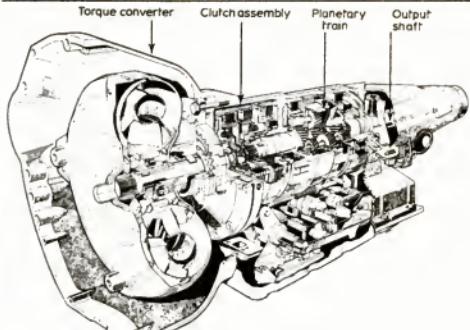


Figure 6 A conventional automatic gearbox has a torque converter and an epicyclic geartrain

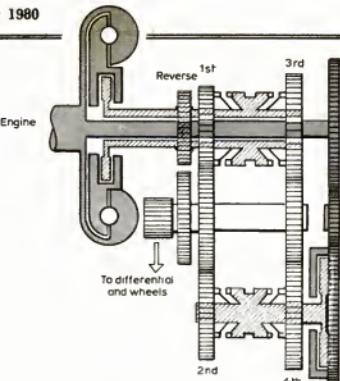


Figure 7 British company AP has devised a way of making a manual gearbox continuously variable

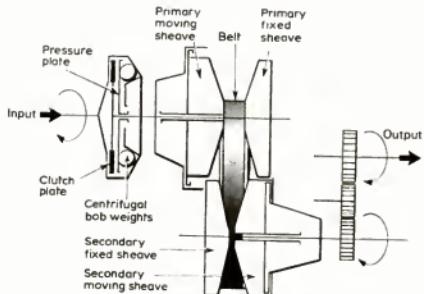


Figure 8 Van Doorne developed the Daf transmission but its successor, called Transmatic, is better and being fitted to Fiats

some because it requires two large rubber drive belts, while the frictional losses in these and elsewhere in the system reduce its efficiency to the level of a conventional automatic transmission.

But now, the original creator of the Variomatic design—Van Doorne of Holland, which is independent of Volvo—is developing a new continuously-variable transmission which promises to be highly efficient and no more bulky than an ordinary manual gearbox. The key component of this new system, called Transmatic, is a low-loss, drive belt of linked steel blocks. Each pulley (Figure 8) has a V-shaped groove formed by a fixed flange (or sheave) and a sliding one. When the sliding flange moves inwards the drive belt is forced outwards to run at a larger diameter. Conversely, when the sliding flange moves out, the belt runs on a smaller circumference. The position of the moving flange on one pulley is controlled by engine speed and load while the other is spring loaded to set itself to the opposite of the primary pulley. Like the Variomatic transmission, early versions of this system had a centrifugal clutch, but the company's engineers will probably choose a form of low-loss, fluid coupling for production versions.

The Transmatic system is now being developed by Borg Warner, the independent automatic transmission manufacturer, in conjunction with Fiat and Van Doorne. The system is ideal for use in front-wheel drive, transverse-engined cars so that it seems sure of a ready market. With a possible ratio range of 6:1, however, it has obvious potential for fuel saving and a number of companies including BL with Borg Warner is developing it.

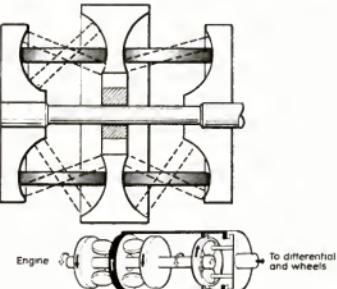


Figure 9 Forbes Perry thought up this novel variable transmission; it has both potential and problems

Another intriguing possibility is the toroidal roller concept developed and improved in the 1960s by Forbes Perry of Perbury Engineering in which rollers are mounted between sets of discs with toroidal or scooped surfaces. Tilting the rollers (Figure 9) alters the ratio between the two outer driving discs, A, and the centre driven disc, B. Although the coefficient of friction involved is very low, the system can transmit as much power in relation to its size and weight as conventional gearboxes, and can provide a ratio range of around 6:1.

The Perbury system needs an additional coupling device and extra gears to provide reverse gear. But this problem can be solved neatly by coupling the transmission through two clutches to an epicyclic gear train and allowing the driver to select, in effect, a geared neutral. Lowering the ratio of the toroidal drive will give reverse motion while raising it will give a forward gear. Because the transmission is highly efficient, it should be a fuel saver.

That is the technology which will provide the motorist of the next few years with a fuel consumption of 42 mile/gal. And it is not too fanciful to imagine that the next generation of engines to appear in the mid 1980s, perhaps using a high-compression May-type system of combustion (New Scientist, vol 85, p 560) will give the same order of improvement. Together these techniques could give a small family car a fuel consumption of over 50 mile/gal when driven hard, but nearer 60-70 mile/gal when used gently. And this doesn't take into account what engineers are doing to cut the rolling resistance of tyres, to reduce the weight of suspensions, and to streamline body shapes. □



## Can computers win gold medals?

Computer technology allows us to analyse athletic performance in more detail than ever before.

We can learn why some athletes win and how others might ...

*Gideon Ariel uses an electronic pen to trace a film frame of a shot putter; a computer simultaneously displays the image*

**Dr Gideon Ariel**  
is director of research  
at Computerized  
Biomedical Analysis  
Inc, Amherst,  
Massachusetts

All top athletes are highly trained: but why are some so obviously better than others? In the past, performance depended largely on raw talent; and was improved by training, new subtleties of technique, and better equipment. But now the computer is giving a new edge of exactitude to training, technique and selection of athletes. It can help us to relate an athlete's performance precisely to what he does; and also to find out why some people are innately better equipped for particular events than others.

To throw, run or jump, the human body must obey the same physical laws as all other earthly objects; the laws of motion govern its performance. It is impossible to throw the shot 70 feet (21.3 metres) if the thrower cannot achieve the right shot velocity and angle of release. These values do not vary from athlete to athlete; for each particular shot velocity there is one optimum angle. If a person wants to leap 29 feet (9 m)—as only one man in history, Bob Beamon, has ever done—he must produce forces on the ground that will propel his body with a specific force of reaction at a particular angle. This force is unique: it is impossible to cover the same distance with less force, as gravitational forces act uniformly, whoever is jumping.

Biomechanical research relies primarily on data from high speed cine films and measurements of body motion and forces. The data comprise *kinematic data*, including a description of the motion in terms of the displacement, velocities and acceleration of parts of the body; and *kinetic data* consisting of the measurement of forces, moments of force and analysis of the body's centre of gravity. Computer technology helps us to combine the results of high-

speed photography with the anatomical data so that we can find the best use of the human body, and reduces long tedious hours of tracing and hand calculations to a matter of minutes.

In the technique we have developed at Computerized Biomechanical Analysis Incorporated we photograph the athlete in action and project the developed film on a "digitiser screen". We then touch the image's joints with a stylus which transmits the X-Y coordinates of each point touched to a computer memory. As each frame of the film is digitised the computer writes the points on a graphic display and connects them by lines to form "stick figures". In this way an athlete's complete movement can be re-created as a series of stick figures on the screen and we can follow the movement of different parts of the body (see Boxes). Repeating these procedures for several camera views produces 3-dimensional analyses of the action; at least two cameras are needed to give two lines of sight to define the position of any point in space.

To calculate the forces, and moment of force, we need to know the mass of each body segment, or limb, as well as its centre of gravity; a publication by the Aerospace Medical Research Laboratory supplies the necessary values. A program we have developed computes the lengths, angular displacements, velocities and accelerations for each body segment. Using the graphics display we then observe the effects of adjusting the values of these variables until they best reproduce the curve followed by a particular point of the body during the movement filmed. That is, the displacement of each body segment from frame to frame is adjusted independently to obtain the best smooth "fit" to the raw data; this is necessary to overcome human errors inherent in the digitising process.

## Men with big muscles



Yuri Sedyh took the gold medal for hammer throwing at the 1976 Olympics in Montreal

At one time, American throwers dominated most field events, including the hammer throw. In recent years, however, Americans have not been able to throw the hammer as far as athletes from the USSR and the Eastern bloc countries. At the Montreal Olympic Games, no American threw the hammer further than the qualifying standard of 226 feet (68.8 metres), although 25 Soviet athletes did so. That year's gold medal winner was Yuri Sedyh, shown in action above.

Our analysis showed that the shorter throws of the American athletes were paralleled by relatively low velocities during the turns, with correspondingly low linear velocities of the hammer. These velocities were low because the Americans displaced their centres of gravity inefficiently.

Pulling on the handle of a hammer, to accelerate it, is like pulling on the knob to open a door that's jammed. If you lean forward with your feet behind you, you cannot pull back on the knob because you have nothing to pull against. You have to place your feet between your body and the door-knob and push against your feet. If you keep your legs straight as you lean back, you have only your body weight to pull with, but if you bend your legs first you can then push with your leg muscles as you try to straighten them, producing a force greater than your body weight. Another important point is that you can apply the most force to the doorknob by pulling straight out rather than at an angle. This means that you must lower your body so that the arms are horizontal. The American throwers do not use this technique—but the more successful Europeans have perfected it. □



CBA INC - PERFORMANCE PROFILE  
VORONIN 110 KG

Alexander Voronin, preparing for the 1976 Olympics (above). Computer graphic displays of Voronin's lift (right) and of other East European lifters, showed why these athletes perform more efficiently than their American counterparts



POSITION 26 -- SEGMENT 00

Weightlifting was once an event of American glory, but the US has now lost its prowess to the Eastern Europeans—perhaps because the recent winners have improved their techniques. The graphic display above portrays a Russian weightlifter. Bulgarians, Soviets and East Germans have developed coordinated techniques that allow the lifters to get under the weight when the bar is at a lower point than for the less successful athletes; but the Europeans are still able to accelerate the bar upward from the lower position. Our studies indicate that weightlifters in the US delayed getting under the bar until the bar had begun accelerating downward. They could not therefore lift greater loads because once the weight was descending, a lifter had to overcome the inertial forces and the weight of the bar.

We also observed that, in European lifters, the path of the weight coincides with the path of the athlete's centre of gravity. This was not so with American athletes, who performed less efficiently. □



### The anatomy of a dive

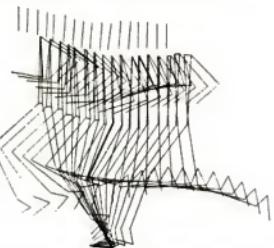
Diving is judged in aesthetic terms as well as in terms of performance. The American, Greg Louganis (above), has a unique technique which allows him to perform better than most divers. Our research revealed that Louganis's method of absorbing kinetic energy from the diving board differs from that of other divers we tested. Louganis employs a coordinated movement in which he first collapses his knees. At the same time he throws his arms downward, directing the force in the board upwards. This is counteracted by the collapsing knees. When his knee joints reach an angle of approximately 90 degrees, he abruptly slows the downward movement of his body. With this movement he loads the diving board with potential energy; that is, he reaches an unlikely position in which his knees are bent (so he is ready to spring) while the board is bent downwards, and ready to spring back. At this point, Louganis accelerates his arms upward, creating an additional downward force which adds to the decelerating force of the body, and increases the loading force on the diving board.

When his arms are approximately horizontal, Louganis begins to slow them down again. At the same instance that his arms begin to decelerate, the diving board starts to unload its potential energy, converting it to kinetic energy. At this point, Louganis prepares for the dive, with the diving board providing the upward force. In other words, from this point onwards Louganis is able to concentrate solely on the diving stunt, without being required to make more effort. Most other divers provide muscular forces throughout the dive—which is less efficient than in Louganis's technique. □

### The elasticity of the long distance runner

C B A INC - PERFORMANCE PROFILE

BILL ROGERS REGULAR MARATHON PACE



Long distance running is generally considered to be a "cardio-vascular event"—one that depends mainly on the athlete's ability to pump blood round his body. Our studies have revealed that biomechanical factors are extremely important, as the demands on the heart and circulation depend on the individual's work output, which in turn depends on the length of his strides and their frequency. Some studies have suggested that running with long strides has the advantage of reducing the number of strides over a given distance. However, our work has indicated that a braking force stops the forward motion of the athlete; the larger the stride, the greater the resulting braking force.

This phenomenon depends on the relationship between the body's centre of gravity and the front foot's point of contact with the ground. We found that if a runner extends the forward leg so that the contact point is ahead of the body's centre of gravity this produces a greater braking force, and makes the running motion less efficient; an athlete's optimum stride is when the braking force is minimum. By calculating the precise relationship between stride and braking force for an individual athlete we can improve his running efficiency by as much as 20 per cent. Leaning forward slightly at the hip joint also makes a runner more efficient, as does landing on the ball of the foot rather than on the heel—something that efficient runners often do.

Our measurements of angular displacements at the knee and ankle joints revealed that running involves large amounts of elastic energy. The muscles associated with running contract before the foot hits the track. The muscular contraction absorbs kinetic energy which is later released to propel the athlete forwards. This is rather like bouncing a basketball. A properly inflated ball stores the energy put into the bounce, and uses most of this energy in the rebound—that is, elastically. The average runner does not store elastic energy efficiently; he dissipates the energy like a basketball with too little air, which you have to bounce harder, only to find it does not go as high. The better runner is the one who can absorb more elastic kinetic energy, in analogy to bouncing an over-inflated basketball.

So the average runner requires more energy in each step, compared with the elite athlete who retains elastic energy. Future research should show whether an athlete can acquire or increase elastic energy through training. □

With data from NASA on the location of the centres of gravity of body segments, the program can also calculate the displacement, velocity and acceleration of these centres of gravity, and can again "fit" the movement smoothly with computed curves. We then pass this information on to the coaches and athletes. For example, we can investigate what happens if small adjustments are made to certain parts of an athlete's movement, by studying the effects on a selection of four athletic events, and show how we can learn to improve techniques through making the best use of the body as a physical system.

Tony Duff/Allsport

# Monitor

## Is Mercury's high density an 85-year old mistake?

The presently accepted mass of the planet Mercury is 50 per cent too high, according to Raymond Lyttleton of Cambridge University. His evidence for this astonishing claim is strong enough to persuade scientists at the Jet Propulsion Laboratory to re-analyse data from Mariner 10's fly-bys of the planet in 1974/5.

Mercury's accepted mass and diameter make it a peculiar world, with a density almost as high as the Earth's, even though it is only one-third the diameter and so should be much less compressed at the centre. Lyttleton, an expert on planetary interiors, has for many years been suspicious of Mercury's high density. Planetary scientists generally envisage that Mercury has a huge iron core to produce the high mean density, presumably as a result of its proximity to the Sun when it formed. Lyttleton points out that there is no progression in iron content among the other inner planets, though; and as a result of his suspicions he has investigated the source of the presently quoted radius and mass of Mercury.

He found no reason to quibble with the radius of Mercury, based on radar results and photographs from the Mariner 10 fly-bys. But the mass turned out to be a different story, as Lyttleton revealed in a recent seminar at Cambridge's Institute of Astronomy.

### Predators learn to avoid bright food

Students of animal coloration assume that brightly coloured animals are either distasteful themselves or resemble a distasteful species. Leaving mimics aside, it has been assumed that conspicuous markings are an asset because although they help predators to find you they also help predators to learn that your markings are associated with a meal that is nasty and thus not to eat you. Conspicuous, or aposematic, animals often live in groups of related kin, so although they may die they will, in so doing, teach their killers a sharp lesson and thereby protect their kin more effectively than if all the family was inconspicuous.

As a theory this is fine, except that it lacks support from evidence. John Gittleman at Sussex University has now shown that the theory is right; predators do learn to avoid distasteful prey more quickly if it is conspicuous.

Gittleman, with his colleagues Paul Harvey and Paul Greenwood, used week-old chicks as predators. And as prey he used ordinary chick crumbs, coloured with food dye and made distasteful with a mixture of quinine and mustard. Prey, then, could be either blue or green and either tasty or nasty. The floor of Gittleman's test arena could be either blue or green, so he could present a chick with a choice of two foods, one conspicuous and the other inconspicuous (cryptic is the technical term), one

Nigel Henbest

Mercury has no satellites, and its mass has traditionally been based on its very small perturbations of the orbit of Venus. In 1895, the eminent American astronomer Simon Newcomb deduced a mass of 0.055 Earths—just one-six millionth of the mass of the Sun.

Newcomb's value for Mercury's mass for long remained standard—as late as 1964 the International Astronomical Union was quoting it. But when Lyttleton looked at Newcomb's published works, he discovered that although Newcomb says "for the mass of Mercury I took 1/6 000 000", his calculations actually give a value of 1/8 405 000!

Historians of science will no doubt theorise over why Newcomb quoted a



Mercury may be due for a transfer from the heavyweight class

distasteful and the other bland.

Each chick got to prey on the food seven times, each time being allowed to peck at 100 crumbs. The results were clear. The chicks took far more of the conspicuous crumbs—blue on a green floor or green on a blue floor—at first. But if the conspicuous food tasted bad they took less and less each time, until after four sessions they were taking equal amounts of distasteful food regardless of background. After this crossover the chicks learn to avoid the conspicuous distasteful food more quickly than the cryptic distasteful food (*Animal Behaviour*, vol 28, p 897).

That seems to support the theory that distasteful prey are brightly coloured because it helps predators to learn not to take that prey. But wait. In the first four test sessions the chicks that had a choice between conspicuous-nasty and cryptic-tasty ate far more nasty food than those whose nasty prey was cryptic. Indeed, on the very first trial they ate more nasty food than the others got in all seven trials. Another experiment (*Nature*, vol 286, p 149) did not offer chicks a choice, but simply looked at how much food they ate in two conditions, conspicuous-nasty and cryptic-tasty.

Again the chicks took more of the conspicuous food at first, regardless of taste, but quickly learned to stop eating the food, even though they were hungry.

different result. On page 170 of his *Elements of the Four Inner Planets* his calculations produce 1/7 943 000 Suns, with the errors allowing a mass as high as 1/5 890 000 or as low as 1/12 210 000. But there is a "definite adjustment" which Newcomb quotes but does not apply (although he does apply it to Venus's calculated mass). Lyttleton finds that this adjustment decreases the mass to 1/8 405 000 Suns, with limits 1/6 71 000 to 1/12 220 000.

But five pages later, without further explanation, he gives 1/6 000 000—and even says "actually it seems that this mass is larger than the most probable one". Lyttleton points out that this mass is in fact outside Newcomb's permissible range when the calculation is completed. However, Newcomb's "real" value of 1/8 405 000 Suns (0.040 Earths) is close to what Lyttleton expects if Mercury has a similar internal structure to the other inner planets.

Many astronomers would argue that this is indeed just a matter for historians: Newcomb's values have now been supplanted by new techniques, principally the radar tracking of Venus, and Mercury's gravitational deflection of the Mariner 10 spaceprobe—and both agree well with Newcomb's chosen value (1/6 021 000 and 1/6 023 600 respectively). The agreement between radar ▶

With cryptic-nasty food they didn't eat as much at first, but they continued to take the nasty food so that by the end of the experiment they had eaten more cryptic unpalatable prey than conspicuous unpalatable prey.

Gittleman's experiments show that fewer distasteful prey are eaten in toto when the prey are conspicuous than when they are cryptic. They don't show why this is so. It might be that eating a lot of distasteful prey in one hit, as the chicks do when they first find the conspicuous prey, provides a more salient learning experience. Or perhaps the chicks simply notice the conspicuous prey and remember it better. Either way, it is good to see an assumption being supported by evidence. □



Larva of wanderer butterfly—prospective predators can easily see it, but soon find it doesn't taste very nice to eat

# Monitor

continued

◀ and spaceprobe results seems to confirm that Mercury's mass is near 1/6 020 000 Suns. But not necessarily. In the radar measurements of Venus, for example, 28 different quantities were extracted from the data. To find all these, a starting value is assumed for each, the expected results are then compared with observation, and the starting values are adjusted until the fit is better, according to a "least-squares" procedure. The process is then repeated with the adjusted starting values. This technique is beyond reproach—but only if the starting values are close to the true values.

Lyttleton believes that both methods for determining Mercury's mass have suffered from this effect. Mariner 10 did not go into orbit around Mercury, but just flew past the planet, so Mercury's gravitational pull is only one of several dozen parameters included in a least-squares fit; in the radar case, it is one of 28. Lyttleton contends that as the starting mass of Mercury was in each case based on Newcomb's unfounded 1/6 000 000 Suns, both sets of calculations should be reworked with a starting mass of 1/8 500 000 or 1/9 000 000 Suns.

John D. Anderson, head of the Mariner 10 tracking team at the Jet Propulsion Laboratory, Pasadena, does not agree. He told *New Scientist* that he disputes that there is such a strong dependence on starting value, although it is "a remote possibility". He sees the agreement between the radar results (from three different observatories) and the spaceprobe results (from two close fly-bys) as strong confirmation of the accepted value; and using this value has produced no anomalies when Mariner 10's computed path has been compared to the results of its instruments.

But Anderson does concede that when "someone of the stature of Lyttleton" has questioned the result, and shown the starting value has no real basis, he is prepared to look again. Over the next few months, he will re-run the Mariner 10 data reduction programmes, starting with Lyttleton's 30 per cent lower mass for Mercury. Anderson, however, expects the mass to increase to the higher value by the end of the calculation. He is also going to investigate the data themselves, for he thinks he can show analytically—without resorting to least-squares—that Mercury's mass must be close to the accepted 1/6 000 000.

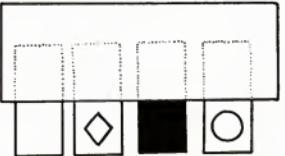
Either way the result will be intriguing. If Lyttleton is wrong, and Mercury's presently accepted high mass and density are confirmed, it will mean that Simon Newcomb had the apparently psychic ability to know the correct mass of Mercury, even though it differed from his calculations. Lyttleton is, however, convinced that a new figure will emerge. A much lower mass for Mercury will make its interior structure more in line with the other inner planets; and it will mean a drastic rethink of present theories of the formation of the inner planets, including the Earth. □

## Wason test: it's normal to get it wrong

The Wason four-card problem is one brainteaser people may be chagrined about solving. Only about 4 per cent of university students give the right answer, which is a dubious distinction. The other group of people who almost always get it right are those with damage to the right hemisphere of the brain. Most normal people respond promptly; confidently and incorrectly.

At the start of the test, the subject sees eight cards. Each card has two panels; one panel contains either a star or a diamond, and the other panel contains a solid colour (in this article, either black or white). None of the cards has two shapes or two solid-colour panels.

The eight cards are taken away, and the subject is shown four new cards, masked so that only one panel of each card is visible (see Figure). The person is asked to state what could be on the invisible panel of each card.



*A damaged right hemisphere appears to be an asset in solving this brainteaser*

Finally, subjects are presented with this statement: "Whenever there is a circle on one half of the card there is a black on the other half of the card." The task is to name those cards and only those cards the subject would need to unmask in order to establish whether that sentence is true or false for those four cards. It is not necessary to unmask all four cards.

## Bacteria improve crop production

Farmers can improve some crops by adding certain bacteria to the soil, according to T. V. Sluslow, J. W. Kloepper, M. N. Schroth and T. J. Burr at the University of California at Berkeley (*California Agriculture*, vol 33, p 15). Their results back up those of scientists in the USSR, who have claimed for some time that adding root-colonising bacteria to the soil benefited 50 to 70 per cent of field crops, with yield increases ranging from 10 to 13 per cent.

The California scientists use the acronym PGPR for the plant-growth-promoting rhizobacteria whose effects they investigated. They isolated several hundred strains of bacteria from the excised roots of field-grown plants—then selected the likeliest candidates by checking whether they could inhibit the growth of various pathogenic bacteria and fungi or promote the growth of roots and shoots. This procedure selected 1 to 4 per cent of rhizobacteria from

Psychologist Evelyn Golding, who uses the test to study people with damaged right hemispheres, thinks they solve it easily because such damage interferes with their ability to perceive visible objects normally. They uniformly fail the "unconventional angles test", in which they are shown an object photographed from an unexpected vantage point. In Golding's version, they describe a basket photographed from the top as a doily or the end of a log; normal people still see it as a basket.

Golding, who works at the National Hospital for Nervous Diseases in London, thinks this defect in perception leaves the brain free to concentrate on the verbal, logical aspects of the problem. She hopes studies of the few normal people who pass the test may clarify how the two sides of the brain interact. For the rest of us, she feels, perception of shapes and colours distracts the brain from its verbal and logical assignment.

To test her assertion, Golding asked 20 people with normal right hemispheres to do the test after they had finished a session of mild electroconvulsive therapy (ECT) to the right side of their brains for chronic depression. This treatment halts right-hemisphere function, but only for a few minutes.

Half of her ECT-treated subjects invalidated themselves by recovering their right-brain function too quickly, as shown by passing the unconventional angles test. Two of the others turned out to have vision problems that interfered with the Wason test. The remaining eight all succeeded in solving the four-card problem.

Those who want to try the Wason test should read no further. For those ready to be enlightened, the solution to the four-card problem is to uncover the card with the circle and the one with the white panel. □

potato and sugar beet as potential PGPR. Most of these fell within the *Pseudomonas putida* and *P. fluorescens* groups, though not coinciding exactly with any currently described strains.

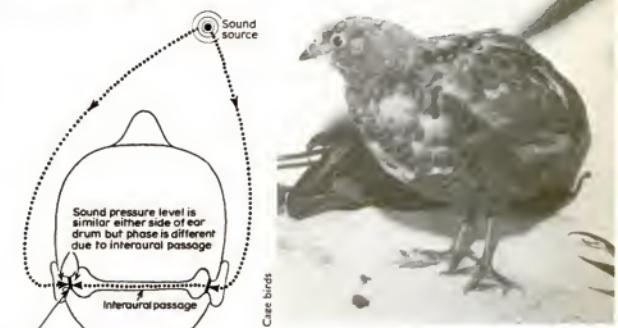
Sluslow and his colleagues applied PGPR to potato seed pieces, sugar beet and radish seeds in powder form. They found that the beet seedlings increased in vigour and the root growth of the radishes and potatoes showed significantly greater elongation of their underground stems and earlier formation of tubers. Increases in the final yields ranged from 5 to 33 per cent in 7 of 11 plots sited in California and Idaho. There were also greater yields with sugar beet grown from PGPR treated seeds, these ranging from 4470 to 8534 kg per hectare, with the total sucrose production being increased by 1051 to 1366 kg per hectare. Even better results were achieved with radishes, the root weight being boosted by 60 to 144 per cent. □

## Birds heed sound with a hole through the head

Birds home in on sound by using the hole through their head between their ears to amplify the phase difference of signals arriving at either ear. A British team working on the Japanese quail and scientists in the US investigating chickens agree that this is the way birds get over the problem of having a small head.

Small-headed animals have difficulty placing sounds because the size of cues such as differences in phase and intensity between sound waves reaching each ear become smaller and so more difficult to interpret for animals with a narrow head. The air-filled passage that joins the birds' two eardrums is a device to enhance the sound intensity difference between the two ears. The intensity difference depends on two factors: the actual direction of the sound source and its frequency. So, a sound source of mixed frequencies in a particular direction from the bird's head will produce a particular pattern of intensity differences whose size depends on frequency between the two ears. The same sound in another direction will produce a distinct pattern of intensity differences.

Researchers have recently begun to investigate exactly how the bird's "hole through the head" works. A five-man team, headed by Brian Lewis based in London at the Department of Biology of the City of London Polytechnic, has



The Japanese quail (above) works out where sounds are coming from by using a hole through its head to amplify phase differences of sounds arriving at either ear (left)

chosen the Japanese quail to investigate the problem, while John Rosowski and James Saunders at the Department of Physiology, University of Pennsylvania used the chicken (*Journal of Comparative Physiology*, vol 136, p 183).

Using miniature probe microphones both teams recorded the sound pressure

gives it enough angular momentum to be able to produce a noticeable shift in the spin of the whole Earth from time to time. The effect may be measured only in milliseconds, but this is literally a wind that shakes the world.

Changes in the contribution of the atmosphere to the total angular momentum occur with changes in the zonal circulation, shifting parcels of air towards or away from the equator. And the FGGE results will be of particular interest to anyone who has followed the story of how variations in the solar wind affect the weather on Earth. Walter Orr Roberts and colleagues have shown over the years that bursts of solar activity can be related to changes in the weather patterns at high northern latitudes. It seems that the arrival of an extra large flux of particles in the solar wind in some way stimulates the development of low pressure systems sweeping from west to east at the latitude of Alaska or Northern Europe. In terms of atmospheric circulation, this is equivalent to a shift of air mass of just the kind which the FGGE results now confirm can produce a measurable, if short-lived, change in the length of day. And this suggests that the observational evidence for a link between the changing level of solar activity over the sunspot cycle and the changing length of day at the level of millisecond variations, long regarded with suspicion by both astronomers and geophysicists, might now be taken without the previously obligatory pinch of salt. □

level produced at the eardrum and within the interaural passage when sounds of different frequency were presented at various points around the bird's head. They also recorded readily detectable electrical responses by placing an electrode on the cochlea, to the same sounds. The signal produced in this way gives a simple indication of the general response of the ear to sound.

Both teams showed that sound is attenuated as it passes across the ear drum but is little attenuated as it travels across the head. However, the important feature is that while a sound has been travelling across the head sound has also been travelling around the head and thus the eardrum responds to the sound received simultaneously from these two sources. While the amplitude of these two sounds impinging either side of one eardrum are similar, their phase is, however, different, and the actual instantaneous sound pressure level acting on the eardrum will be quite different to what it would have been had sound travelled to it only from outside the head. The difference between the sound pressure produced externally at the two ears are small; but the actual difference in sound pressure detected by the ear drum is very much larger and so provides the bird with a reliable cue for placing sounds.

The two research teams refer to the mechanism differently. Lewis and his London team call it a pressure gradient receiver while the Americans label it a partial differential pressure transducer. Whatever it should be called, the mechanism is an ingenious one for overcoming the problem of sound localisation with a small head. These findings also reinforce the close affinity of birds with reptiles which also have a hole through the head and may also use a mechanism for amplifying phase differences in placing sounds. □

## Wind that shakes the world

New observations of wind and pressure variations over the globe, made as part of the Global Atmospheric Research Programme (GARP), have provided detailed information about the way in which changes in atmospheric circulation can affect the rotation of the solid Earth. The measurements were made during the First GARP Global Experiment (FGGE), which ran for a year from December 1978. They show in particular that a change of about one millisecond in the length of day, which occurred between 21 January and 7 February last year, and another change of about 1.5 ms between 18 May and 2 June, can be best explained as the effects of atmospheric changes.

The idea that the circulation of the atmosphere effects the spin of the Earth on this sort of scale is not new, and it has long been known that a seasonal variation in the length of day on a scale of milliseconds results from the seasonal shifts of great air currents over the globe. But the new work, reported by Ray Hide and colleagues in *Nature* (vol 286, p 114) marks one of the first direct measurements of related changes in atmospheric circulation and length of day on a timescale of a few days. The observations agree very well with theoretical predictions, which show that although the atmosphere has much less mass than the solid Earth, its position on the outer skin of our spinning planet

# Technology

## Now Britain tunes in to TV from space

The Home Office has just finished canvassing television broadcasters, the aerospace industry and other interested parties about whether the UK should have a TV satellite of its own. It has just received comments from organisations like the BBC, GEC and broadcasting unions and will assimilate these into a report which will be published later this year.

France and Germany have already agreed to develop independently of the European Space Agency (ESA), the TV-Sat system to relay television programmes from a central transmitter, through a geostationary satellite 36 000 km above the Earth, into homes. But Italy could be the first in Europe to start up "direct broadcast" TV transmissions from ESA's L-Sat spacecraft.

"Pre-operational" versions of the German and French TV-Sats will be launched by the European Ariane 1 booster rocket in December 1983 and mid-1984 respectively with fully operational spacecraft being put in orbit by the end of 1985. Each satellite will provide three television channels at first, and five later, to individual rooftop aerials measuring only 70 cm by 90 cm.

The first example of ESA's L-Sat (large satellite) is expected to be launched in 1983 and will, among other equipment, carry a single-channel "pre-operational" direct-broadcast TV service, for Italy. Italy, unlike France and Germany, has no plans at present to proceed to a fully operational service.

Switzerland is also in the market, and British Aerospace in collaboration with Thorn-EMI and Thames Television has proposed a direct-broadcast TV service for that country. One of the main ways in which such a service could be financed is by advertising, and here the Swiss have a distinct advantage. Switzerland is a small country, but its three official languages—French, German and Italian—are spoken by neighbouring countries. Supposedly all-Swiss, directly broadcast TV services could obviously rake in advertising from these countries on the grounds that the transmissions could be picked up over a large area.

### Airgun shoots a new line for safety

Last week tanker operators and representatives of HM Coastguard watched a demonstration of a novel technique for passing lines between ships at sea that could make the rocket line obsolete. Plummett, a company based in Horsham, has produced a prototype compressed-air, line-firing gun, based on the ideas of inventor "Mac" McDonald Praine.

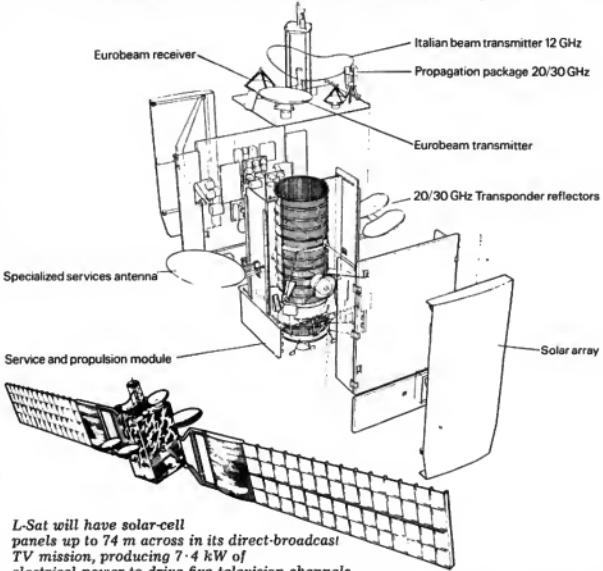
The line-throwing gun is essential to safety at sea. The safety of the crew of a stranded or sinking ship can depend on getting a line to it from the shore or another vessel, and lines passed easily can make the task of mooring unwieldy tankers, or transferring stores and cargo while at sea, faster and more reliable.

Britain's Home Office has recognised that direct broadcasting of TV programmes could bring a whole host of problems and has set up a committee to study the advisability of establishing such a service.

Direct broadcasting of television would offer Britain a further five television channels starting up between 1985 and 1990. Signals could be picked up either by rooftop domestic aerials about 80 cm in diameter and costing between £100 and £200, or by a larger community aerial which feeds individual sets by cables. The position allocated to Britain for a direct-broadcast satellite is at 31° West over the Equator which means that

such a satellite would lie at an angle of approximately 35° West of true South and at an elevation of 25° in London or 20° in Edinburgh. Anyone who could find an unobstructed line of sight on his premises to the satellite would be able to receive programmes from it.

Satellite broadcasting differs from conventional terrestrial services in two important respects. Full national coverage can be achieved by a single satellite, but it is not possible to transmit regional programmes. This is one of the problems being investigated by the Home Office committee, which is also examining a wide range of technical, environmental, social and financial questions. □

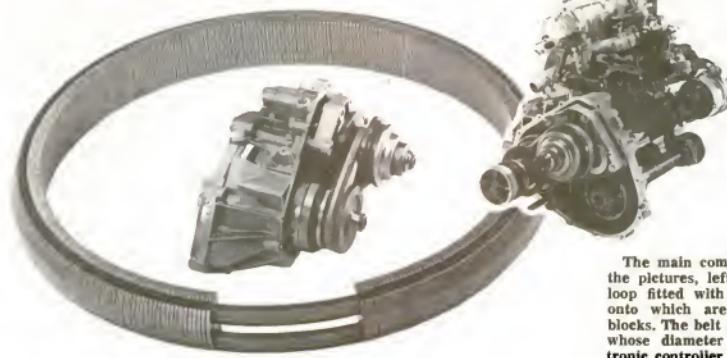


and the gun is ready to fire. The "firing pin" simply starts the projectile on its way and when it breaks the lower seal the compressed air launches it.

Cost of the launcher is likely to be around £1500, roughly the same price as a Coastguard-approved rocket launcher plus six £125 rockets. But each launch should cost no more than £1 and the projectile is re-useable.

Plummett hopes to be producing its line-thrower by this autumn. But it might have to move fast. McDonald Praine and a BP Tankers official believe that Dunlop is busy developing its own compressed-air gun—in which the projectile would be fired when the pressure had built up enough to break a shear-pin—though the company denies this. □

## Belt drive is an automatic fuel saver



Fiat has just started proving trials of the continuously variable transmission that has been developed by Borg Warner and Van Doorn (see Tony Curtis's article on advanced transmissions, page 279). The Transmatic gearbox, which should cost no more than a conventional automatic, will be fitted to the Ritmo, or Strada as it is called here.

The main components can be seen in the pictures, left. The belt is a rubber loop fitted with concentric steel bands onto which are fitted hardened steel blocks. The belt runs in the two pulleys, whose diameter is varied by an electronic controller that responds to engine speed, throttle setting and road speed to cut fuel consumption to 8 per cent less than a normal automatic. □

## Tune a TV into IBM

British engineers have improved the chances of viewdata becoming part of office information systems by making it possible to link TV sets with computers manufactured by IBM. This means that a company could use a TV set for its own viewdata service if it has access to the information already held in its IBM computer.

With the public Prestel service, the domestic or business TV is tied to information held on computers owned by the Post Office. Companies like Philips sell viewdata services, tailored to particular needs and run on a computer dedicated to viewdata.

### One step towards digital sound

DBX, the US manufacturer of recording noise reduction systems which is now owned by Britain's BSR, is offering domestic listeners a system to bridge the gap between conventional analogue and future digital discs. Sound from a digital master tape is recorded in analogue fashion, on an ordinary LP disc, but encoded with DBX noise reduction. When replayed on a conventional gramophone connected to a DBX decoder costing around £79, the disc produces sound quality comparable with the original digital recording. The first batch of DBX records, cost around £10 each and offer a dynamic range (difference between quietest and loudest sound) of 90 dB. This is close to the dynamic range of a digital studio tape recorder.

The DBX system has so far been used mainly by professional and semi-professional tape recordists to reduce background hiss. The dynamic range of the music signal is artificially compressed by a factor of 2:1 before recording. This

Now, as part of its R1800 office system, the British company Redifon has now made it possible to link a TV set to an IBM computer, its own system for private viewdata, or the public Prestel service. When linked to an IBM machine, the set can operate as if it were a standard IBM visual display unit (a screen plus associated keyboard).

This kind of link between a TV set and a general purpose computer is not unique—ICL, for example, has a computer, the ME29, which can do the same thing. But IBM does dominate the commercial computer market—it makes at least 60 per cent of all computers for

increases the average level of sound loaded onto the tape so that it is never lost in background noise. For playback, the noise-free signal is expanded by a similar factor to open out the volume range again. The snag is that some hiss comes and goes or "pumps", as the

this area. So Redifon's innovation offers many more users scope for adopting a viewdata network.

Redifon's R1800 office system also includes a device which allows a computer to recognise handwritten characters. The device called, Writaway, is based on the Micropad, made by the British manufacturer Quest Automation.

New software developed by Redifon allows users to integrate Writaway with other information handling systems like viewdata. A clerk could, for example, tell the computer about orders from customers, and instruct the machine to put the information on to a viewdata page to be circulated electronically to relevant managers. □

music changes volume. Digital master tapes have no hiss, so DBX discs made from digital masters do not pump.

Only listeners with very expensive hi-fi systems will be able to gain full benefit from DBX discs without distorting the sound or damaging their speakers. □

### Where the bee sucks, a geologist follows

Geologists may be changing their rock-picks and assay equipment for a bee-keeper's hat and a mass spectrometer, if a prospecting technique developed by Dr Harry Warren, emeritus professor at the University of British Columbia, catches on.

The technique is based on the very simple idea that pollen contains trace

elements that can give a clue to the location of useful mineral deposits. A pollen trap at the entrance to a bee hive scrapes off pollen particles from the flowers bees have visited in the vicinity. In theory, any mineral that appears in unusual concentrations as a trace element in the pollen must be present in at least a small pocket somewhere near.

Warren has been trying to prove the technique by obtaining readings from various sites around British Columbia, some near the mines, some not. He has, for example, found that pollen from hives in the area of the Afton copper mine near Kamloops has a copper concentration of 54 parts per million against only 15 ppm in another town where lead and zinc are smelted. □



# Technology

continued

## Airships get a Redcoat and a green light

The long-heralded return of the airship in competition with the energy-expensive aeroplane for carrying people or cargo took a step closer to reality recently. Redcoat Cargo Airlines of Surrey, has agreed to buy four 600 ft long rigid airships by 1984 that can carry 58 tonnes at up to 86 miles per hour.

The specially designed Skyships R40 will be built by Airship Industries, once called Thermoskyships and renamed after taking over a company called Airship Developments, which built the AD500 at Cardington, Bedfordshire. Redcoat plans to fly its airships on routes to Africa, the Middle East and across the Atlantic. Prototypes should be in the

air in late 1983 and operations should start by 1984.

Kevin McPhillips, Redcoat's managing director, believes that soaring fuel costs will drive many air freight companies out of business. That is why his company is opting out of aeroplanes permanently in favour of airships.

Each of the novel freighters will cost £4 million compared with \$60 million for a Boeing 747 which can carry 100 tonnes at a cruising speed of 550 mph. Skyship R40 will use 75 per cent less fuel per tonne of cargo than most aircraft and will carry 2½ times as much cargo per tonne of fuel consumed. The airship will be able to carry bulky cargoes too—its

hold will have a volume of 1070 cu.m, 56 per cent greater than a Jumbo. Freight rates should fall, says McPhillips, by at least 29 per cent over conventional narrow bodied freight planes.

Skyship R40 will be kept aloft by 14 840 cu.m of helium and the craft will be powered by four 857 kW (1150 hp) Pratt & Whitney PT6A-50 turboprop engines in swivelling mounts. The pilot will be able to land the airship vertically, obviating the need for runways.

The airline plans to use each Skyship for 6000 hours per year—more than twice as long as Britannia aircraft are in the air—and the craft will spend most of their life aloft, operating mainly over the sea at an altitude of 3000 ft.

As the R40 will not need runways, landing sites will be far cheaper to build than conventional airports, and cargoes could be flown direct from factory to factory or to terminals within city limits. A transatlantic crossing or a flight to the Middle East or West Africa would take 2½ days—between three and seven times faster than a ship. Though Redcoat will use the airships solely for freight, it is considering the possibility of carrying passengers.

Next summer, a small demonstration airship, the former AD500 now renamed the NR2, will be flown in England to gain piloting and handling experience. This 164 ft long craft will carry two tonnes.

Britain's Civil Aviation Authority is "positive" about the practicality of the proposals McPhillips says, and is helping the company to establish requirements for airworthiness. Redcoat say it is confident of getting the money it needs (over £16 million) from financial sources that normally support aircraft ventures. It is currently looking for a base from which to operate, probably near an industrial centre like the Midlands, and has been talking to British Steel about a construction site on which to build the new craft. □

## Water is a disc's best friend

One of the best known record cleaning fluids is D3. It is made by Discwasher Inc of the US and costs 99p for one fluid ounce in British shops. Dr Bruce Maier, its inventor, declined to give any clue to its content when he spoke to the British press last February.

But US patents 3 951 841 and 3 965 520 explain why—the patents say that Discwasher's favoured fluid is over 99.9 per cent distilled water. The patent claims that Discwasher will kill off fungi and bacteria which live and breed in the grooves of a vinyl disc thereby degrading reproduction—their excrement fouls the groove. Discwasher's patent proposes a

groove while the propylene glycol lubricates the record surface. As the surfactant, either Triton XI14 or N57 from Rohm and Haas are recommended.

Surprisingly, the file index of the British Patent Office shows no trace of a corresponding patent to protect the D3 formula in the UK. □

But the technique may be valuable as a first-line, non-invasive means of scanning children who have indefinite symptoms. It may also prove useful for distinguishing between different muscular weakening diseases.

Preliminary results at the Hammersmith Hospital suggest that ultrasound can distinguish between different variations of muscular diseases. It could be of special value in the early diagnosis of some non-progressive neuromuscular diseases, where such diagnosis can allow a large measure of rehabilitation through physiotherapy.

But the key to the future of the technique could lie in the limited results gained so far. The fact that properly used ultrasound can reveal diffuse abnormalities within tissues, as well as showing up abnormalities on boundaries and surfaces, is likely to stimulate more interest in using the technique in this way. □



range of fluids to prevent this growth, but favours a mix of 0.004 per cent by weight of sodium azide, 0.005 per cent of propylene glycol, 0.075 per cent of surfactant (or wetting agent) and 99.916 per cent of distilled water. The sodium azide kills any living organisms in the

Doctors at the Hammersmith Hospital are experimenting with ultrasound for diagnosing and investigating muscular dystrophy. Ultrasound from an ordinary B-scan machine is reflected from fatty cells which invade diseased muscles. This means that the tissue within the muscles appears stippled with white on the television screen used to display the picture, in contrast to the uniform dark appearance of normal muscle. Dr John Heckmatt, the paediatrician who has developed the technique, is trying to determine how early doctors who are using the technique will be able to diagnose muscular dystrophy compared with traditional methods, and how accurately the television pictures follow the progress of the disease.

It is unlikely that ultrasonic scanning will ever replace conventional biochemical tests, particularly those that involve raising enzyme levels, which can diagnose multiple sclerosis at a very early stage.

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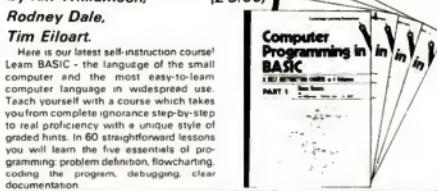
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# How cells select amino acids

Traditional theories hold that the cell chooses the amino acids it needs at their point of entry. It seems, however, that the cell lets in all-comers and takes the amino acids required for protein synthesis from a free internal pool

**Dr Denys Wheatley**  
is senior lecturer in  
cellular pathology at  
the University of  
Aberdeen

Proteins are the workhorses of living cells. They direct the cell's chemical reactions by acting as living catalysts and they are also very important in the physical structure of bodies. Cells make proteins from amino acids, following the instructions encoded on the DNA, and get rid of them either by exporting manufactured protein to other parts of the body or by breaking proteins down when they are no longer useful. The balance between synthesis (anabolism) and breakdown (catabolism) is obviously a fine one; any deficiency in the manufacture of proteins and the cell will die, while the slightest imbalance in favour of synthesis will inevitably lead to growth. Could it be that deranged protein metabolism is one cause of cancer (which, after all, is an uncontrolled growth in cells that should not be growing)?

Dr Robert Holley, of the Salk Institute in San Diego, California, certainly thinks so, and points to the observation that transformed cells, that is cells that have been made cancerous in tissue culture, are not as good at regulating their use of amino acids as untransformed cells. Although we understand a great deal of the biochemistry of protein synthesis, we know very little about the fine-tuning regulatory mechanisms that operate at the cellular level; in view of the possible connections between these mechanisms and cancer, I think we would do well to look in more detail at how the cell walks the tightrope of synthesis and degradation.

The movement of amino acids from the outside to the inside of the cell has long been considered an important aspect of the regulation of protein synthesis, and a great deal of work, notably in the laboratory of Dr Halvor Christensen at the University of Michigan, has led to the discovery of six different types of transport site in the cell membrane—sites at which the amino acids enter the cell. The implication is that the cell controls the uptake of amino acids by controlling these specific transport sites. Failure of Control, says Holley, could result in cancer.

One of the problems that the cell faces is that of selection. Proteins are made from 20 different amino acids, and although some proteins, such as histone and collagen, have large amounts of one particular amino acid, in the living world the proportions of the 20 amino acids are relatively constant. How does a cell ensure that it gets the right amount of each amino acid?

There are two answers to this question, one orthodox and one more heterodox. The orthodox view is that a cell takes in each amino acid by attaching it to a carrier protein and hauling the protein-amino acid complex across the membrane. Energy to power the pump comes from an enzyme that breaks down adenine triphosphate (ATP) in the presence of sodium ions, and six or seven of these carrier systems have been identified by virtue of the amino acids they carry, their special requirements for sodium ions, pH, and so on. Once inside the cell, the amino acid is available for synthesis of whatever the cell needs.

This basic scheme of amino acid uptake is shown in Figure 1, and it might be called the "classical membrane-transport theory". It demands that many complex systems in the membrane be highly organised in order to respond to the needs of the cell—and in fact many prokaryotes (bacteria, roughly speaking) do have similar carrier sys-

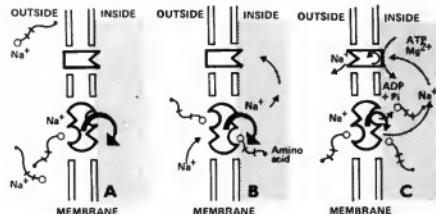


Figure 1 The classical membrane-transport hypothesis

- A. The carrier loads up and flips over
- B. Amino acid passengers released inside cell; sites on reverse of carrier now ready for loading on the outside Na<sup>+</sup> picked up by pump in membrane
- C. Na<sup>+</sup> secreted by pump allowing more in through carrier and bringing more amino acids in. Carrier may transfer some ions out of the cell, possibly K<sup>+</sup>, when it flips. Most of the energy requirement is consumed in moving Na<sup>+</sup> out of the cell

tems that transport nutrients into the cell. But if this involved and rather dubious hypothesis is applied to eukaryotes (all other living things—again roughly speaking) it fails to explain some of the simplest observations of amino acid uptake and utilisation. This had led to a new scheme which I call the "alternative hypothesis".

Two findings in particular make an alternative hypothesis necessary. One is that the classical theory cannot account for the way a cell absorbs the analogue of a particular amino acid—that is a close chemical relation—in the presence of the amino acid itself. The other disturbing finding is that if one adds a radioactive amino acid to cells and follows the progress of the labelled tracer, one finds that it is incorporated without delay into cellular proteins, and at a constant rate. If it were first being pumped across the membrane and then diffusing through the cell, one would expect the rate of incorporation to accelerate as the label reached the ribosomes where the proteins are being made (Figure 2). It does not, and further pursuit of these problems only confirmed the need for a new hypothesis.

When one adds an amino acid to the medium in which a culture of cells is growing, one finds that the concentration inside the cell very quickly comes to equal the con-

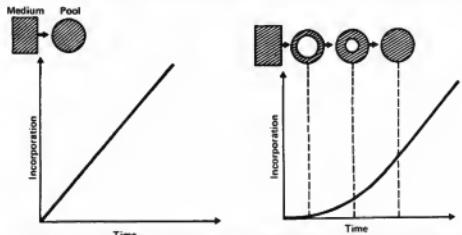


Figure 2 Incorporation of radioactive amino acids into proteins. A pump that needed enzymes for transport would show accelerating incorporation, as right. In fact, incorporation is linear, left

centration in the medium, and may even exceed it. Earlier workers simply did not see this; there was some evidence of limited diffusion but, apart from some researchers at the Carnegie Institute in Washington in the 1950s, no one suspected that there was any large-scale diffusion. The reason turned out to be simple. To measure uptake of amino acids, cells are first incubated with radioactively labelled amino acids and then washed to remove all traces of the radioactive medium from the outside. Just as the amino acids diffuse into the cell from the medium, so too they will diffuse out of the cell if the concentration outside drops; three washes with saline provides a steep concentration gradient out of the cell, down which the labelled amino acids make their escape.

#### Amino acids diffuse across membranes

Free rapid diffusion of amino acids into the cells explains the "anomalous" linear incorporation into proteins, and there are good reasons why the amino acids should be able to diffuse through the membrane with ease. They are small: the biggest is cystine, with a molecular weight of 240. They are electrically neutral because the amino (positive) and carboxyl (negative) groups are adjacent and effectively neutralise each other. Other relatively uncharged molecules 5 to 10 times bigger cross membranes rapidly without the benefit of specific transport sites (for example, bleomycin, an antibiotic), and there is no reason why amino acids should not behave in the same way. Some further evidence for rapid diffusion comes from the way that the cells of marine animals respond to changes in the concentration of the medium by rapidly shunting amino acids in and out of their cells, from the movements of transmitters in nerves (neurotransmitters are usually amino acids or modifications of them), and from exchange reactions that would be hundreds of times slower if they took place through carrier-mediated transport. But we still await definitive tests that show very rapid movement of amino acids across cell membranes.

What happens to the amino acids once they reach the cytoplasm inside the cell? Again there are differing views. Obviously, free diffusion would produce a "pool" of free amino acids inside the cell. So, too, in the classical theory, amino acids released from the carrier should be in the free form. The amino acid is said to be free in the latter case simply because it appears unchanged after the larger molecules have been precipitated with weak organic acids, such as sulphosalicylic or trichloroacetic acid. But as the amino acid does not diffuse out we can presume that at least in the conventional acid-extractable pool it exists inside the cell in an altered form. The important point is that we can now delineate two major pools in the cell—one of which contains truly free amino acid and the other of which contains amino acids that become free only after treatment with acids.

To look at the problems posed by the two pools we turned our attention to the energy-driven transport mechanisms of the classical theory. Energy is supplied by enzymes breaking down ATP, but when we looked at the uptake of 14 different amino acids we found that none of them showed any hint of being involved in a process that depended on enzymes for transport. Six amino acids that we looked at in detail made ever larger pools inside the cell as we raised the external concentration. Indeed, the pool kept growing up to external concentrations of 0.04 M; at this level the cells might even become damaged but the acid-extractable pool was still not full. (For comparison, normally cells grow in a nutrient medium with 0.001 M amino acids.) An energy-driven membrane pump could not produce this sort of result because the pump would have a top speed and would show what we call saturation kinetics. It now seems that the acid-extractable pool is "virtually unsaturation", as Yaacov Hod and Avram Hershko of the Technion in Haifa, Israel, describe it. If the cell

must use energy to pump amino acids into itself then the formation of these huge internal pools of amino acids—especially of analogues that are not use in protein synthesis—would squander its ATP reserves; such a wholesale wastage would not be not only uneconomical but also highly improbable.

Perhaps the most persuasive evidence in favour of the alternative hypothesis comes from studying the relationship between the rate at which amino acids enter the acid-extractable pool and the rate at which they are incorporated into newly synthesised proteins. In brief, there is no correlation between the two processes; the rate of protein synthesis does not depend on the concentration of amino acids inside the cell, except of course where an amino acid becomes extremely limiting or is completely absent. This is dramatically demonstrated if one produces a large pool of the amino acid phenylalanine inside the cell and then resuspends the cells in a medium that contains the analogue *p*-fluorophenylalanine; instead of using phenylalanine—which is present in quantity and is preferred by the enzymes that guide protein synthesis—the cells incorporate the analogue into the proteins they are making.

The overall picture is rather paradoxical; amino acids diffuse into cells where some form pools from which they cannot readily diffuse out, yet yet these pools are not the immediate reservoirs of amino acids for protein synthesis. So what is the true function of these acid-extractable pools?

When we looked at the way that amino acids left the acid-extractable pool, it became clear that they are bound to some substance from which they have to dissociate in order to be truly free. It seems that the pool represents

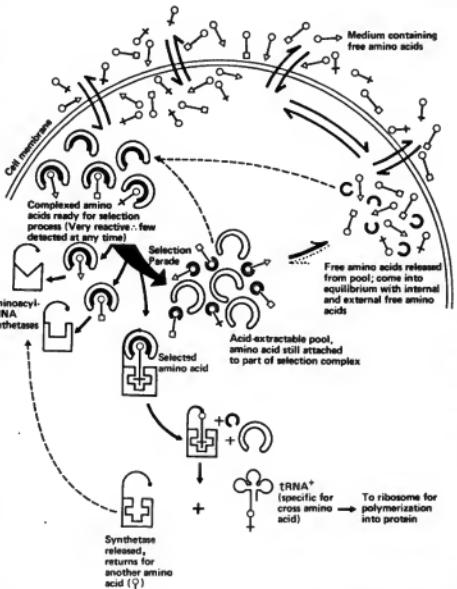


Figure 3 The new, alternative, hypothesis. This summarises our ideas about how amino acids are taken up and made available to the cell. Arrows represent reactions, and solid arrows take place faster, or more readily, than dotted arrows. The system is self-regulating and the membrane plays no part in selecting amino acids.

the excess of amino acids; not so much a supply of precursors but the opposite, a sink for "postcursors". The acid-extractable pool, which for so long has been seen as the result of uphill transport to bring nutrients into the cell and a measure of synthetic activity or growth, becomes instead a depository into which the cell dumps amino acids that are no longer available for protein synthesis, prior to discharging them.

The alternative hypothesis can explain the experimental data on the behaviour of amino acids much more convincingly than the classical theory. Like all new models it will have to be subjected to rigorous testing which may take many years, but in the meantime, I present the essential features of the model here. The annotations to the diagram (Figure 3) provide some clarification and details, and although there is not space for a full discussion, two points deserve further comment.

#### Advantages of the alternative hypothesis

The first is that this model would be self-regulating, whereas the classical theory needs controls on the many different ports of entry. The second brings us back to the problem I mentioned earlier, that the cell has to obtain all 20 amino acids in the correct proportions. It is highly improbable that the nutrient supply to the cell will contain the amino acids in exactly the right concentrations; indeed their balance will usually be entirely wrong. Furthermore, in life the composition of a nutrient medium can change drastically from one moment to the next. Diffusion alone cannot help us with this problem, but the detailed reactions of the model can.

The cell gets what it needs by converting the free amino acids into a special bound form. All amino acids will combine with the binding units, including quite unnatural ana-

logues. The newly bound amino acids are presented to a group of enzymes called aminoacyl-tRNA synthetases in a kind of selection parade. There is at least one such enzyme for each of the 20 natural amino acids, but none for the unusual ones, and it is the job of these enzymes to attach the correct amino acid to its specific tRNA molecules. The tRNA molecules take the captured amino acid off to the ribosomes where they decode the message on the mRNA and, if appropriate, insert their amino acid into the growing protein chain.

The rate at which the aminoacyl-tRNA synthetases can select amino acids will depend on the amount of enzyme available, and is far slower than the binding of the amino acids to the form that the synthetases select, which is a very fast process. Turnover among the selection forms is very rapid, which ensures that at each instant a new set of amino acids becomes available for the synthetases to select from; if the synthetases are in the correct proportions they cannot fail to select the amino acids in the correct proportions. Those bound amino acids that are not almost immediately selected—the overwhelming majority—partially break up, leaving the amino acid still bound to one component. In this form the amino acid cannot escape from the cell and is not available for protein synthesis; this is the acid-extractable pool. The bound amino acids in the pool spontaneously decay, freeing the amino acid to leave the cell or be rebound for possible selection by an aminoacyl-tRNA synthetase.

This sequence of reactions constitutes a cyclical perfusion system that operates throughout the cytoplasm of the cell. The proportions of the amino acids made available for synthesis of proteins remain constant, and with such a system the cell can satisfy its nutritional requirements even in the face of an extremely adverse environment; the flexibility of the system confers enormous survival value on the cell that possesses it.

My model, in contrast to the classical membrane-transport theory, stresses that selection of amino acids is random until the amino acid is attached to the aminoacyl-tRNA synthetase; after this point the amino acid is committed to protein synthesis and will be incorporated into a protein. The classical theory is much more strongly deterministic and requires controls at each stage, from the very start of an amino acid's journey into the cell.

The cyclical perfusion/selection system allows the cell much more freedom to satisfy its amino acid requirements under all sorts of conditions but it cannot regulate what is done with the amino acids. It will cope admirably with whatever weird mix of amino acids is presented to it, but the actual business of regulating protein synthesis must be downstream of the perfusion/selection system.

The main controls of protein synthesis are probably centrally located, at the level of the production of mRNA, tRNA and aminoacyl-tRNA synthetases. These alone can decide what type of protein, and how much of it, the cell will produce, and it is these controls that will be influenced by the myriad factors that are known to affect cell growth. This is the very opposite of the ideas I began with, which saw the control of nutrient availability at the cell membrane as a key regulatory mechanism. Whatever it is that allows cells to become cancerous it isn't connected with membrane regulation of amino acids.

It was some 30 years ago that Harry Eagle of the National Institutes of Health in the US, doyen of nutritional studies of cultured cells, drew attention to the fact that the composition of the amino acid pool inside cells is but a reflection of the composition of the surrounding medium and not the mix needed for synthesis of proteins. It seems that we now have an explanation of why this should be so and it is an explanation that also tells us how the cell can feed itself by a mechanism that is simple and self-regulating. □

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# Review

## Knock twice for no

### Science and the supernatural

by John Taylor

Temple Smith, pp 180, £7.50

Enter, right, John Taylor to sighs of relief and mutterings of "I told you so" from fellow members of the scientific community. The errant erstwhile believer—or so it seemed—in the paranormal has calmly, almost clinically, made up his mind. He has searched for the supernatural and not found it. Instead he has uncovered only "poor experimentation, shoddy theory and human gullibility".

It has taken Taylor seven years to arrive at these unequivocal conclusions, seven years since he was invited by the BBC to wield a scientific hatchet on Uri Geller when he appeared—live—with David Dimbleby. The programme was an astonishing experience for Taylor. The spoon-bending, mind-reading, watch-starting Israeli was not only making himself the most talked about performer since Harry Houdini. He was also, before the eyes of millions of excited viewers (their senses charged by the Miss World contest that had just been screened) threatening to subvert the principle on which any scientific career is founded. Reason. Something, in short, had to be done.

This slightly overpriced book is a record of what Taylor has been doing to apply the method of science to the investigation of the paranormal. He writes simply and directly for a lay reader, explaining such notions as replication and quantification with the ease of a practised communicator. His starting point is that if psychic energy is anything it must be electromagnetism which ought to be measurable.

Thus, together with Eduard Balanovski he sets out to observe experimentally phenomena such as psychic healing and telepathy—being in a typically British fashion restricted in the signal frequencies he could explore because the apparatus required was too expensive. The results are invariably negative. Tests on a dowser to see whether his powers derived from an ability to detect the presence or absence of a magnetic field likewise came to nought. The dowser had absolutely no signal from a field of 500 gauss, and indeed refused to waste his and the experimenters' time by endeavouring to detect one.

Looking at psychokinesis—the moving of objects without touching them—Taylor and Balanovski are obliged to consider the much-publicised feats of the Russian Alla Vinogradova who has a distinctive way with coins, matches, table tennis balls and plastic pen caps. Here they can offer an explanation, albeit one that will be dispiriting for the psychic set. Vinogradova's powers are considerable but they stem from her highly skilled usage of static electricity. The fluency, it seems, deserts her when it is sugg-

### Fever - its biology, evolution and function

by M. J. Kluger

Princeton UP, pp 195, £8.60

In this monograph Professor Kluger persuasively presents evidence from many sources that fever evolved as a defence mechanism in poikilothermic fishes and reptiles. *Paramecium*, bumble bees and lizards all add to the evidence presented. From this starting point he goes on to question the previous thesis, more prevalent in North America than Europe, that all fever in man is inherently undesirable and should be treated by antipyretics such as aspirin. He discusses the temperature regulation of mammals in great detail, comparing it with lower orders of animals and using it as the basis of his contention.

Overall the book provides a comprehensive review of the comparative physiology of temperature regulation and of the pathogenesis of fever. This approach does much to place human temperature regulation and its abnormalities in its correct context as part of a generally occurring biological reflex, rather than a phenomenon exclusive to mammals. However, the evidence for considering fever, unless extreme, as a potentially beneficial occurrence in disease in



Associated Newspapers

Key-bending Geller—superstar but not supernatural

gested that she repeat her movement of objects on a metal table. She prefers to stick to plastic.

At the end of the day very little of the paranormal is left undemolished. What has not been explained away by fraud and the laws of nature is too thinly documented anyway. But there are two problem

man, is less well presented. The average clinician will not be much impressed by extrapolation from fishes and reptiles, the only species where the adaptive value for fever may be regarded as proven beyond reasonable doubt, to patients.

Nevertheless, it is pleasing to read a book which seeks to accelerate the reversal of doubtful dogma. Fever therapy

*Earth, space and time* by J. G. Navarra (Wiley, pp 438, £9.50). The most important discovery made in man's voyages into space (out-rivaling even Jupiter's viscous technicolours), has to have been that of the view of home-sweet-home. The picture of the Earth that adorned bedside walls through the 1970s has had an extraordinary effect in shifting consciousness. Our globe became something to marvel at, to become aware of its insignificance within the immensity, and—feeling sensitive of its childlike vulnerability—to befriend. *Earth, Space and Time* is a product of this image. For convenience the Earth becomes divided into its various shells of activity: the geosphere, the biosphere, the hydrosphere and the atmosphere. Through following the inter-dependencies of these systems in flux the Earth's wholeness emerges.

This is an ambitious under-

areas, two allegedly supernatural phenomena that Taylor the scientist has not yet been able to explain: psychic healing and that terrifying autodestruct mechanism known as spontaneous human combustion. Perhaps here is the seed of another book?

While we are waiting for it we must acknowledge that this one is a timely *profession de foi* from a man who at times has seemed to be undecided on whether to wear the garb of the gamekeeper or the poacher. He is seen here in his true colours. And yet he manages subtly to convey a certain sympathy with the causes he is shattering, a willingness to be convinced where others would have closed the issue. He will not make any converts among believers in the paranormal but, at the same time, he probably will not alienate many of them either. That in itself makes the book an unusual phenomenon.

Peter Evans

in venereal disease is touched on, as also is its possible role in tumour therapy.

Although not as exhaustive in its cover of the literature as the *Physiological Society Monograph on temperature regulation* published several years ago, it is a useful book for anyone seeking a moderately comprehensive current review on the subject.

David Taylor

taking—the Earth resists reduction to 400 pages. Despite the gawky title and an ugly cover, the contents have achieved these intentions with a general success. Intended as a textbook for the American college market—for students not specialising in any of the sciences—in translation into UK terms it might be suitable for A-level or even O-level courses. Other details of the presentation also suggest that for "Earth" read "America": many of the geological examples are from the US.

Navarra has had his *weltanschauung* nurtured on the wall picture—he is not one of those truly remarkable men who became globalised by inference. And although the overall coverage is ambitious and competent the knowledge occasionally grows thin. Such deficiencies do not, however, undermine what is both a provocative and useful book.

Robert Muir Wood

## Review

continued

**Biology and crime**edited by C. R. Jeffery  
Sage, pp 160, £8, pb £4

It may seem far-fetched in these days of sociology and political science to suggest that a person's biology is at the root of all crime. In view of the horror aroused by the film *A Clockwork Orange* it seems controversial—to put it mildly—to suggest that medical science should (or could) be used to cure criminals. In *Biology and Crime* the editor—himself a lawyer turned biologist—puts forward the case for both; argued by a formidable array of professors of biology, psychology, psychiatry, law and political science.

The book is divided into two main sections, "Biology and the individual offender" and "Biosocial and biopolitical implications of biology". The first deals with some of the current work on the psychology and brains of criminals, and in particular of violent criminals. The chapters deal

mainly with how violence could be controlled biologically; for instance, by using drugs, lesioning parts of the brain, or implanting electrodes into the brain. Into this section comes a chapter with the intriguing title "The violent brain—is it everyone's brain?" This chapter discusses the environmental causes of violence in mice (violence can be apparently encouraged by alarmingly small variations in handling techniques) and testosterone levels as an indicator of violent tendencies. Although some of the experiments quoted in these chapters are interesting, the authors did not consider deeply enough the question of how far research on the brains of mice can be applied to men. Moreover none of the (themselves rather brutal) techniques for "curing" criminals could be relevant to more than a very small proportion of criminals—a fact that left me feeling at the end of this section, that the book should have been called *Biology and Homicidal*



*Maniacs*. This criticism does not apply across the board, and there was one excellent chapter on the use of orthomolecular medicine as a means of keeping people in a good (and presumably non-crinal) frame of mind.

In the second part of *Biology and Crime* the discussion centred on more general questions, considering

the role of the psychiatrist, theories of criminal behaviour patterns and the link between behaviour studies and politics. These chapters were, for me, unsatisfactorily woolly; in conclusion the book has failed to persuade me that biology is of much use either as a tool to find cures for crime or as a means to understand it.

Tessa Livingstone

in this volume—Cody included—gave their lives to the conquest of the air. Their dedication was absolute, and this book is testimony and tribute to their sacrifice.

Philip Jarrett

**British aviation:****the pioneer years**

by Harald Penrose

Cassell, pp 308, £19.95

This book first appeared in 1965, when it was published by Putnam. It has now undergone some revision, and is presented in landscape format with pages of approximately twice the original size and additional text and illustrations, though the brief biographies of leading personalities are absent.

Harald Penrose has provided a readable survey of aeronautical developments in Britain during 1903-14 (he actually opens his story in the 19th century), but many of the factual errors in the first edition are still evident. Some have been corrected, but are replaced by new ones in the captions to some of the additional pictures. Regrettably they are careless mistakes which mar an absorbing and well-written narrative.

The author's greatest problem was obviously to condense a full and fascinating story into a limited space, and in consequence the reader faces a barrage of facts but is given little insight into their relative significance to the whole. In a general history this lack

of evaluation leaves the lay reader somewhat bewildered; he is at the mercy of the author, and can only assess the importance of a particular subject by the space devoted to it.

This can be misleading. For example, because a large section of the book is devoted to the ambitious Maxim biplane of 1894, one might be forgiven for thinking that it greatly influenced the development of British aviation. In fact, despite the masterly engineering it embodied, this machine's influence was small, it was not a success and it does not merit such extensive coverage in book of this sort.

Nonetheless, the period covered receives scant attention, and a book as comprehensive as this is to be welcomed. The birth of Britain's greatest aircraft companies—Avro, Blackburn, de Havilland, Short Brothers, Sopwith, Vickers, Handley Page and Bristol—came about during these years of endeavour, their founders often struggling with dogged determination against poverty, pessimism and bureaucracy to pursue their goal.

Their story is one of the triumph of individuals, and in those days aviation had a generous share of eccentrics, including "Colonel" S. F. Cody,

the erstwhile Wild West showman who made the first powered, sustained and controlled flight in Great Britain on 16 October, 1908.

Sadly, many of the pioneers who pass fleetingly before us

**The Ringworld engineers**

by Larry Niven

Gollancz, pp 354, £6.50

Don't look back. Sequels are very seldom as good as the originals which inspire them, and *The Ringworld Engineers* is no exception to this rule. The original, of course, was *Ringworld*, the novel in which Niven wrapped up and rounded off his tales of "known space" with mystery and adventure involving an artificial planet made in a ring around its sun.

Ten years later, pressed by eager correspondents, the author has produced a resolution to the mysteries wrapped up in some rather mundane adventures. He leaves me, at least, feeling rather let down, in the same way that no *Sherlock Holmes* book can ever be quite the same after the hero's miraculous escape at the Reichenbach Falls.

The formula here, down to the cast of main characters, is very much as before. There is no new "science", so

that the story has to be carried by the mystery (the disappointing resolution to which is telegraphed far too early) and adventure, where the main character has such powerful technological aids that his exploits resemble "and with one bound he was free". Worst of all, the resolution of the mystery really doesn't fit the history of Niven's known space universe, with too many key characters forced by the exigencies of the plot to carry out acts which Niven aficionados know to be impossible for their species.

With all its faults, the book still makes a good read if you don't stop to think too hard, preferably digested in one sitting on a train or plane journey. We expect more from Niven, but *The Ringworld Engineers* beats most of the opposition. And at least now he should have exorcised the *Ringworld* ghost; with this out of the way, and the fans perhaps just disappointed enough to leave him alone, let's hope he looks for new pastures next time.

John Gribbin

## The complete book of electric vehicles

by Sheldon R. Shacket

Millington, pp 168, pb £3.95

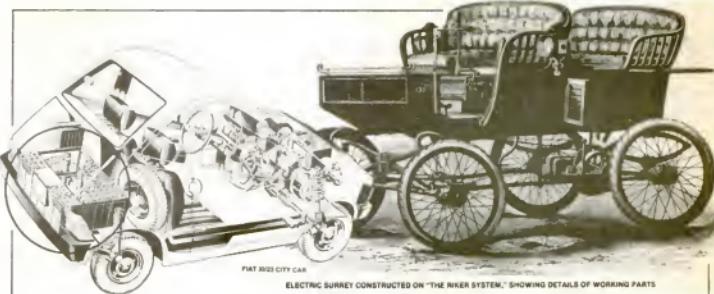
Most people are indifferent to electric vehicles but Sheldon R. Shacket loves them. And his romance with the smooth and silent car of the future shows in every page of his journey through the past, present and future of the electric vehicle. Aside from the history—a long chapter filled with facts, anecdotes and evocative photographs—the book covers the rudiments of electric propulsion for vehicles thoroughly comprehensively.

Shacket traces the rise of the electric car from the battery-powered carriages (often with non-rechargeable batteries) to the "short period" when the electrical vehicle "reigned supreme and became a dominant factor in the personal transport scene prior to the turn of the century". Even in the early 1900s "the electric Brougham and Victoria carriages were the preferred method of transportation among New York's wealthy elite."

Then the death-knell sounded in the form of that unlikely empire crusher—the electric starter motor for internal combustion engines. The wielder of the sword was Charles F. Kettering, one of those men whose incisive mind quickly solved a technical problem that had frustrated engineers since the automobile had been invented. The sword was twisted by Henry Ford with his low cost Model T, forcing the electric car into a coma from which it has never really emerged.

As Shacket says, "While talented designers used their imagination to build electric vehicles of the highest calibre, they had to stand by and watch the world go by while patiently awaiting new technology." They were of course standing by for the more efficient battery—and until recently it seemed that the wait would be unending. An example of the high quality vehicle was the Detroit Electric of 1915 whose range of 80 miles per charge and top speed of 25 miles an hour is not shamed by modern electric vehicles.

In the late 1960s came the "volt-rush" spearheaded by Ford of the UK and General Motors of the US, and cul-



The old and the new: a contemporary battery operated car, and one of its forerunners

minating in such designs as the Enfield Electric, the only 60 of which ever to be sold are still in service of a kind with the UK's Electricity Council.

Then in the 1970s came the energy crisis and the start of a long climb back to commercial reality. Many American engineers believe that with the nickel zinc batteries and zinc chloride "energy storage systems" that are making headlines today the new dawn is breaking and there are plenty

of attempts to prove it. Others, including engineers struggling to make electric cars commercially successful, don't believe they will ever succeed. But if you want to know who worked on which battery, when, and its relative promise, read Shacket's book.

Shacket looks forward with keen anticipation to the day when people glide around smoothly in vehicles whose energy source is indirectly the Sun. "Future generations may

view the antiquated gesticulation of the internal combustion engine as a humorous side note to a misguided era of man's development which relied upon primitive fuels, producing outrageous energy consumption, pollution and wastefulness." A pipedream? Cranky? Perhaps, but paraphrasing Arthur C. Clarke, if a technological forecast seems to be right in today's terms, it is almost certainly wrong.

John Stansell

## Future cook

by Colin Tudge

Mitchell Beazley, pp 256, £10.95

This is not an ordinary cookery book. In fact, to call it a cookery book at all is rather misleading, but you'll find it among the Elizabeth Davids and Delia Smiths in your bookshop. It presents food as something of much greater significance than the average eater ever imagined as he tucked into his meat and two veg. Colin Tudge offers a guide to eating which is nutritionally sound according to the latest precepts of scientific nutritional theory, ecologically sound in a world of dwindling resources and overpopulation, and unfailingly delicious.

Tudge divides all edibles into what he calls food of the first, second and third kinds. Most of the book is taken up with discussing each in turn, accompanied by recipes (many illustrated in colour). Food of the first kind is all you need to stay alive: potatoes, cereals and pulses. These should form the basis of everyone's diet. Food of the second kind provides additional necessary

micronutrients, dietary fibre and equally necessary variety of flavour. It includes meat—quite acceptable future food, but only as an adjunct to the staples—vegetables, as many and as varied as possible, and fungi. Food of the third kind is anything which can add flavour and variety to a dish, but whose nutritional value is unimportant—herbs, flowers, spices, nuts, berries and so on.

To arrive at the ideal future world for this scheme to flourish everywhere requires two revolutions, neither of which is going to take place overnight. One is in the eating habits of the world's population, but chiefly those of the over-fed and meat greedy West; the other, which could arise as a consequence of the first, is in the world's commercial agriculture. Today this is largely geared towards producing, for a relatively small proportion of the population, high protein food which isn't needed. Tomorrow's agriculture, based on the principle that everyone should have at least enough to eat, should concentrate on producing enough food of the first kind to go round, and giving no space to animals that could reasonably be used for

the production of human food. The role of animals is to occupy the odd corners which would inevitably arise, and to eat food which would otherwise be wasted. Meat would therefore become a rarely-eaten delicacy.

Yet Tudge is not a stern figure admonishing us to turn to austerity and self-denial. He combines concern for the future with a real delight in food and its infinite possibilities. His uncomplicated recipes are drawn from the cuisines of the world and often combine two or more influences in the same dish. His rhapsody on the potato (especially the potato chip which, you will be surprised to learn, is not such a nutritional villain after all) is matched in fervour only by his diatribes against deep freezes and TVP (textured vegetable protein). There's a wealth of detail about origins, family relationships, methods of cultivation, animal breeding, nutritional values and culinary possibilities.

Alternately pricking the conscience and tempting the palate, *Future Cook* is a masterly piece of evangelism. Converts should pass the message on. Georgina Ferry

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## Review

continued



### Public view

#### Threatened plants

*British Museum (Natural History), 1 July-30 September*

From an endangered position away from the main thoroughfare, this modest exhibition aims to sum up the pressures which could spell extinction for over 25 000 species of wild plants.

The plant Red Data Book classifies threatened species as rare, vulnerable or endangered. Red data sheets for 250 species in these categories have been published by the IUCN (International Union for the Conservation of Nature and natural resources), a mere one per cent of the above figure.

Habitat reduction stands out as the common denominator—through forest clearance, urban growth, industrial pollution, fire, agriculture, quarrying, tourism, and so on. Control of these factors would largely solve the problem, and each is considered in turn, with worldwide examples. The text is brief and the illustrations are mostly paintings and prints which tend to detract from the urgency of the message. But perhaps this lack of photographs of plants in their natural state demonstrates the scarcity of the species described.

Reality is provided by two cabinets of live plants: endemics of the Canary Islands

grown at Kew, and rare British plants (with a couple from the Balearics thrown in) grown at Cambridge. Apart from possibly prompting people to visit these botanic gardens, they bring the lesson home by showing plants which are in trouble in our own backyard. The most poignant is the sickle-leaved hare's ear (*Bupleurum falcatum*), whose leaves shaped like a bygone tool are now extinct in the wild in England.

The final section focuses on nature reserves. The Gunung Mulu reserve in Sarawak is mentioned as an example of government-sponsored conservation: this should have been cross-referred to a temporary exhibition on the Royal Geographical Society expedition in Sarawak (sited beyond the dinosaurs) which gives an overall picture of that area. There is also in this section an exhortation to support the World Wildlife Fund and your local Naturalists' Trust if you want to help, but with no indication of how to contact these bodies\*.

The heart of the conservation dilemma is that while few of us in the developed world are likely to see tropical forests in the flesh, those who do live among them may only see them as potential agricultural lands.

Julia Grollman

\*Association of County Trusts for Nature Conservation, The Green, Newcastle, Lincoln; World Wildlife Fund, 29 Greville Street, London EC1.

# Forum

## OUT AND ABOUT

### Touchstones of reality

John Hillaby



The year is 1644. Within the walls of York the ruffled chums of Charles I have laid down their long cutlery and surrendered to the Roundheads. In Grub Street, the pamphleteers are eagerly thumbing through John Milton's *Areopagitica*, that great call for the liberty of the press. In Amsterdam, Rembrandt van Rijn has put the finishing touches to "The Woman Taken in Adultery" but in Paris, a little-known jeweller from Lyons—a man who cares neither for politics nor paint—is scurrying about, looking for rich patrons. Jules Bachou has just published *Le Parfaict Joaillier ou Histoire de Pierrieres*, an exquisitely phrased treatise on gemstones. Not an original book. It is, in fact, a translation from the Latin of an earlier work by Anselme Boece de Boot. But had good Master Anselme the wit of Petronius and the tongue of Cicero he could not have matched the verbal jewellery of *éclatant*, *pétillant* or *chatoyance* as you may see it in the eyes of a cat in the dark.

The name of Bachou came to mind about an hour ago when, trapped by a fold in my curtains, an errant beam of sunlight made a microfirework display out of a little pile of semi-precious stones which have been sitting on the rim of this desk since beer was a bob a pint. Iron pyrites, porphyry, chrysoprase, turquoise, heliotrope and that queen of the silica gems, a solitary opal, all contributed to the *pétillant*, but the *chatoyance* came mostly from varieties of quartz, especially those rounded amethysts, citrines and a smoky cairngorm from Skye.

By far the majority of these stones have been picked up on my travels and polished by friends. It is but a fortnight, for example, since I returned from Iona where, tiring of the crowds on the saint-trail, I found that place where the Blessed St Colomba is supposed to have landed with twelve disciples and, as if it marked the spot, came across a pebble of rose quartz, a delicate pink, translucent stone which, even uncut, would have graced a chalice. The colour (and I have learnt among much else from Mr Wooster) is due to a trace of manganese. In all, my collection amounts to no more than about forty or fifty bits of bijouterie but, like rocks laid on cairns by fetishistic trailers, it grows, slowly.

It began under rather dramatic circumstances. From the Chalbi desert, we were heading back to Rudolf, the Jade Sea, that soda lake in North Kenya now called Lake Turkana. Through the buffeting of sandstorms the camels were in bad way. Two had to be killed. Instead of the expected lava wall that might have offered us protection for the night, we breasted a rise to be confronted by the west by blinding white flares. The next morning I discovered they came from large pieces of calcite and curious translucent boulders, pale tonic water blue in colour through which the light of the setting sun flickered as bright as a photographer's flash. I managed to break off bits and brought them back to this journal's office where Peter Stubbs, then our science editor and a dam' good geologist, identified them at once as a cryptocrystalline form of quartz called chalcedony, a red variety of which is known as sard or carnelian.

To those evocative stones I soon added a small chunk of phosphorescent fluorspar (calcium fluoride) from Weardale in County Durham, akin to the stuff from the famous bluejohn mines in Derbyshire, as sought for by connoisseurs, even in Roman times. It lies alongside that smoky cairngorm from the late Gavin Maxwell's shark hunting factory on Soay in the shadow of the Cuillins and carnelian from the bay of that name south of Scarborough. Some rich velvety-green malachite from the Katanga is a constant evoker of the exotic and, though not so beautiful,

fragments of yellowish-green uranium oxide take me back to those hell-deep hard rocks miles under Lake Athabasca on the fringe of the arctic.

The night before I set off for a walk across Britain, I found both serpentine and some rather dull-looking amethysts at Lands End and completed that trudge with a handful of small treasure including garnets from the granite of Glen Dessary and jasper and gypsum in the rubble below Duncansby Head, a mile or two beyond John o' Groats. As they sit there, glowing, on a fine plate which bears marks of the potter's hand, both the amethysts and the garnets awake warm memories. The first name is a misnomer. That purple quartz was originally imported into Greece from Persia where it was known as *sharnes*. Amethyst is clearly a corruption of that word but, having been given the name, pedants assumed it was derived from two Greek words, *a*, meaning without and *methu*, alcohol, the belief being it was a specific against inebriety. It isn't. We gave a piece to old Charlie Waterhouse of the *News Chronicle* who was last seen crawling across the carpet of the Press Club, cutting off the tails of the little devils that beset him with a pair of kitchen scissars. He died in the bin.

As for those garnets from the Scottish Precambrian, they are known to local flockmasters as *Fuil nan slugh* which in Gaelic means the Blood of the Hosts. The legend is that at death the souls of fighting clansmen are gathered up into the air, where for years they are cast backwards and forwards over the hills like migratory birds, unable to gain peace until they make ample expiation for their sins on earth. Sometimes on windy nights they can be heard still fighting in the scud of clouds and in the morning the rocks are spotted with blood.

One difficulty with a love for semi-precious stones is that there is simply no uniformity in common nomenclature. Turquoise, for example, means no more than a stone from Turkey. The Persian name was *smaragdus* whilst in Egypt it was called *mafkat*. Mafkat was often wrongly translated as malachite and Pliny's *smaragdus* is our malachite and to crown all, *smaragdus* is the name the Germans now give to the stone we call an emerald. With, no doubt, the approval of the Chemical Society you might justly refer to turquoise as basic phosphate of copper and aluminium with a touch, a mere trace of iron in it; or jade, out of which the Chinese wrought lapidary marvels, either as sodium magnesium silicate or, if nephrite, as calcium magnesium silicate. But I hope you won't do it in public. It interferes with the *chatoyance*. □

## DEVELOPING WORLD

### Noon will be a few hours late

Joseph Hanlon

When I arrived at Caia station the platform looked as if it was covered with mummies. A dozen or more people, wrapped in white sheets, slept on the platform waiting for the train. Down the track a bit, a few more people slept curled up with their baggage. Two men chatted quietly in the corner. Another listened to a transistor radio. Goats cropped the grass.

Caia is in Mozambique, but that railway platform with its mummies could have been in almost any Third World country. There is only one passenger train a day (and even that train has a few freight wagons as well). The sand road to Beira is so bad that the railway provides virtually the only link with the outside world. The train is supposed to leave at 23.00h and arrive in Beira, 240 km away, at 07.00h. But it never does.

Travelling in developing countries teaches you to sleep anywhere, so I joined everyone else on the platform for the night. The train finally left Caia at 06.00h and arrived in Beira after 18.00h. A few people complained, but not very much—it's all part of the rhythm of rural life.

Because the most striking thing about rural life is that people have so little control over their time. They plant when the rains come and harvest when the crop is ripe. At planting and harvesting they work as many hours as the light allows. If the rains

# Forum

continued

don't come or the crop fails, they don't work because there is no work to do.

So nothing in life leads you to believe that you can plan or control your use of time. Thus there is no reason to complain about waiting hours in queues, and no reason to expect a train to come on time.

This attitude works two ways, however. People see nothing wrong in making other people queue for hours—and no reason why they should ensure that the train is on time. It also leads to the famous Third World bureaucratic attitude that tomorrow will do.

Efficiency and organisation are necessary if people are to make the maximum use of scarce technology. Yet it requires the very existence of that technology to create a climate where organisation is necessary and useful. A farmer with irrigation and a tractor can plan his farming in a way the hoe farmer dependent on the rains cannot. And there is nothing like the desire to listen to a favourite radio programme to encourage someone to wear a watch.

England, the US, and other developed countries went through a long period of inefficient use of technology. Sleeping on the platform at Caiia station, I thought of *High Noon*, the famous American Western movie. The key to the story is that the daily train arrives, promptly, at noon. I'm sure that, like much in *Westerns*, that is a myth too.

But Third World countries are trying to do in a generation what took Britain and the US a century, and without the cheap energy and colonies to exploit. They cannot afford the luxury of using technology wastefully, nor can they wait for a climate of technology to grow so that people begin naturally to demand that trains run on time and object to queuing for hours.

Mozambique is trying to do it in the other direction. Since January there has been a continuing national campaign against bureaucracy, disorganisation, and incompetence. President Samora Machel and cabinet ministers have made surprise visits to factories and warehouses. And the newspapers regularly carry articles about factories working at half capacity or totally paralysed because of a shortage of raw materials, caused by someone within the company or in the government bureaucracy putting off the ordering of essential items.

Every developing country can cite similar examples. But they usually don't, preferring to keep their mistakes quiet. Here, the mistakes are on the front page in an effort to show people that shortages of things they want are due to inefficiency and disorganisation. And thus, that problems can only be solved if they—and everyone else—get organised. It's a brave effort. I hope it works. □

## MEDIA MESSAGES

### Admixture

Tim Robinson

... When it's cold outside, it's heatabix, when you need energy, it's fast on your feetabix, with all the goodness of wheat it's completabix... Get into Orbit, Orbit, Orbit, sugar free gum... One, two, three, it's one to Ski... We'll take more care of you, fly the flag... What did the Taylors fly the flag to France for? —not, I think, to escape from all of that.

Some time during the past fortnight—and how many ads ago is that, I wonder—you may have come across a man from Burke's Peerage. You remember, one of those nice gentlemen who offered to break the *Sunday Times* journalist's legs should he persist in trying to examine the company share register. The occasion I am thinking of did not involve overt threats of violence; rather it was about the publishing crisis at large: people, in these inflationary times, cannot afford the prices publishers all too often put on their wares. Anyway, said the man from Burke's, it's obvious ain't it (I trust he spoke thus, a mixture of ignorance of our language and upper class vowel shortening): from now on books will have to take ads just like the rest of the media world. Just as the new edition of *Burke's Landed Gentry* will, if it ever gets going.

Thus, you will by now have noticed—at least my marketing manager hopes so—that Media Messages, in the forefront of

the times, has entered the heady, nay giddy, future of publishing by being the first column in history to be commercially financed.

Many years ago there was a fear in this country that the Americans would subvert our precious culture with a form of modernism, not least based on what visitors to the States saw advertising over there doing. No-one need have troubled themselves that it would be the Americans who did it to us: we did it without them. Indeed, based on my limited knowledge of American selling techniques, they are a long way behind us.

British advertising—from Schweppes on—has tended to go from here to America: we invented the soft sell, and by so doing discovered the literary advertisement, and the humorous one (the latter has still not been accepted by American agencies). More recently, we have invented the advertisement which does not even mention the product. It does not have to. For a long time students of advertising have watched the evolution of the forms of the medium into a general "sell": advertising beguiles us, less into buying, more into a feeling that we lack *something*. That lack is translated into a warm glow of expectation whenever we positively act by buying, consuming.

The trick of advertising is to be invisible while being very prominent indeed: there's not a place in this culture where you are not liable to be exposed to some form of advertising, be it posters, hoardings, radio, television, cinema, the press. But we're all so used to it: the effect is of a dripping tap on stone, not of a hammer.

"IN GOD'S NAME  
I ENDORSE..."



Over the past couple of decades everyone has been forced into emulating the methods—and more often than not, the actual campaigns of consumer manufacturers and the service industries. Thus the Third World poverty action groups use a stark glossy style; churches emblazon their forecourts like spiritual garages with messages like "God's power beats any energy crisis"; the State—and the political parties—play a cool carefully marketed line on any issue you care to name.

The counter argument of the advertising agencies is that without advertising no-one would know what was available—and there is some truth in that. But it is one thing to know what choices exist; quite another to try to direct choice towards one or other object, as all modern advertising aims to do.

And yet, I maintain, even that distorts a mass of modern advertising which can no longer be said to be aimed at particular objects but at objects in general: the unstated, opposite point of view, is that consumption itself is wrong when it leads to excess.

Some advertising does appear to ask the public to stop: the newer oil company campaigns in the States are hinting that uncontrolled use of petrol might lead to disaster. But again, whose disaster? These huge conglomerates are all too aware of their vulnerability to government intervention should they fail to put their houses in order. And, in any case, their moves to diversify ensure that a reduced consumption of petrol will be more than compensated for elsewhere.

There are limits to advertising set by the law. This is especially true of broadcasting, where various advisory panels sit in the IBA to ensure that, in the words of the advertising industry, all adverts are "legal, decent, honest and truthful."

Yet the limits are penetrated all the time. The IBA consistently has to send back submitted material because it is palpably none of the things it ought to be. More often than not it is sex that is being used to sell something; and the most notorious example in the past has been the Cadbury's Flake ad with its blatant suggestion of oral sex (the old Quakers of Bourneville

would surely just die of shame).

There are other examples of flagrant misuse of broadcast advertising—powerful in effect because it goes direct into the home, and to children. There is supposed to be a clear separation of advertising from other material, for example on commercial radio. But by using the disc jockeys for ad voice-overs, who exactly is kidding whom? Then there is the use of pop record music—the same tunes—for adverts: notice of late the Persil Automatic jingle which is exactly that of the Crystals Da Doo Ron Ron; even the Fiat Strada ad's attempt at up-market identity with Figaro's famous aria from the Barber of Seville. And so it goes on...

Never mind (soothing sexy voice-over), back to reality. . . . There's a difference at MacDonalds . . . You can do it, we can help, one calorie, one calorie . . .

## FROM THE CHALKFACE

### Take a giant step . . .

Eric Deeson

Science teachers have been waiting eagerly for the early 1980s for years—in the hope of a giant step forward in the efficiency of school science education. So who says school science is not efficient? Well, the universities, the employers and the inspectors do not seem entirely happy. The HMI Secondary Survey said "about 10 per cent of the schools (science) provision was unsatisfactory or of poor quality for all pupils." They are right—we don't seem to be doing a good job.

But the list of barriers we must try to overcome each day is alarming. A level of finance that cannot provide for the standard practical needs of our courses, let alone for textbooks; inadequate provision of technical assistance; insufficient laboratory space and facilities; overloaded syllabuses in relation to the usual provision of timetabled contact time; too little opportunity for classroom associated work or personal professional development. Science education simply does not get the resources it must have for success. Far from being efficient, I don't think it is even adequate.

Logic tells us that, unless we change our aims, we must either upgrade the resource provision or reduce the proportion of pupils allowed to study any science subject. Does society want the second approach—leading to even more widespread scientific illiteracy? Surely not—the growing pressures of "science for all" ought not to be resisted, now that this objective shows signs of being achieved. So we must surely improve the provision of resources instead.

That brings me back to the eagerly awaited new age I mentioned at the beginning—the giant step forward in science teaching due now. Two factors should have provided the impetus for this. First, we anticipated Britain's entering a period of relative prosperity due to North Sea oil revenue. Secondly, there was the case of the falling rolls—the dramatic drop in our school population which is indeed taking place. What went wrong? It seems obvious that the country could improve the pupil-teacher ratio at least enough to soak up the effect of falling rolls. Educational standards should rise as a result without additional spending by the individual ratepayer. Surely most teachers, parents and employers (and pupils, and the police) would agree that the education service—and thus the country—would benefit from smaller, better equipped classes; from more non-teaching time for teachers; from more secondments to in-service further training. Yet the giant step seems to be in the other direction—class sizes are rising; the provision of resources is falling.

This is where I start to become chauvinistic, secure in the protection of these pages. If the benefits of Britain's black gold and of our falling rolls cannot—as they should—be spread evenly across the school board, science education must be considered for priority treatment. Otherwise let us forget any ambitions for Britain to be a leader in the 21st century.

Let me restate our main problems in a different way. Science class sizes are generally far too large for proper practical teaching. Timetabled contact time is often inadequate to provide the depth of treatment the exams require. We can't afford the equipment, books and software we would like. Claims for these



deficiencies to be remedied may be contentious—in fact, if I had time to go into the staff common-room, I don't think I would dare. The claims are likely to raise hollow laughs from heads and cries of shame from other colleagues. All the same, fears about the swing from science continue to be voiced—and these fears are justified.

In particular, the question of class size should not cause too much controversy. The principle of teaching "half-class" groups has come to be accepted in other practical subjects (such as woodwork) on the grounds that adequate supervision is not otherwise possible. This special—but sensible—consideration should also be given to science. Here practical work can be at least as hazardous, errors at least as damaging, equipment at least as costly, and close supervision at least as necessary. In Scotland, in many independent schools and in further education, science classes are limited to twenty. They are moving in the right direction.

It must be near impossible to produce successful laboratory practical work at any level with a class as large as thirty. Yet many of us have to try. If the task is attempted with mixed ability groups, poor material resources (one textbook between three), inadequate technical assistance, inadequate preparation time, and inadequate training in new techniques, the possibility of success is reduced even further. No wonder many of us are unwillingly moving away from practical work, back in the direction of traditional methods which we know cannot lead to proper understanding.

## VIEW FROM THE COUNTRY

### Two men and their dogs

Robin Clarke



Five years ago I bought a sheep dog pup. A round, roly, cuddly little thing, of dubious pedigree and unknown parentage. It became known as Ruscoe and when able to do slightly more than an undignified waddle it began to accompany me round the farm.

At the age of some four months, it began to show an interest in sheep—crouching low when it saw one, creeping up alongside me and then jumping up in the air to get

a clearer view of its prey over the tufts of grass which were twice as tall as it was. I taught it to sit down when told to do so. By eight months this canine prodigy was able to round up a field full of sheep. By nine months it would stop doing so when I told it to. By ten months, with a bit of help from me (and I suspect a good bit of acquired learning from the ten ewes I used as guinea pigs), it would put a group of ewes in a pen for me.

At a year the said Ruscoe learnt that if he watched my hands, he would know whether to go left round field of sheep, or to the right. A month later I lost a flock of sheep up the lane, with me and the dog panting after their fast disappearing rear ends. In desperation I told Ruscoe to "get by"—the traditional command for a dog to overtake in a lane, turn the sheep round and bring them back. And Ruscoe did precisely that, although he had never heard the command before. I considered his training complete.

The only sophistication I introduced into this scene—or rather

## Forum

continued

Ruscoe introduced—came from constant practice. Ruscoe soon learnt what I wanted to do with sheep on which field and when. So we virtually gave up communicating. I'd go to the field with him, he'd do the job that was needed, and we came back. Commands became superfluous.

Since when, of course, I have delighted in showing Ruscoe off to those of my more urban visitors I have felt a need to impress. Turning from writer to sheep farmer is one thing, but training a dog at the same time is quite another, particularly when the dog apparently works by remote control.

The truth, of course, is that I didn't train him—apart from teaching him to sit. He already knew it all by some ancestral instinct which must date from a distant wolf relative. But as I could never do my farming without him, and he did everything I wanted, we developed a close and cosy relationship which extended from the fields to the pub and even to holidays on the canal (his very favourite activity). In the country a spoiled sheepdog like Ruscoe is a bit of a rarity. But his work never faltered. The world seemed rosy, and Ruscoe a potential champion whom I had never bothered to enter a trial.

Until that is, I met Merv and Gael. Merv, of course, is Merv the Wern, one of the finest sheep dog handlers Wales has ever seen. Gael is a smooth-haired bitch, one of Merv's six dogs. The meeting came about because I had been asked to write for an American journal on sheep dogs. And though to me my own experience with Ruscoe seemed ample material on which to base the definitive account of sheepdogging, I thought it politic to throw in a few words from an international champion.



So Merv the Wern it was. And he agreed readily enough to talk dogs and show dogs. We did the latter first. A scarcely audible whistle set Gael off round the field. Another changed her direction. A third and the sheep were lined up in front of us, Gael crouched waiting behind. Merv chattered on. "Watch her part 'em", said the Wern. Another whistle, a single leap and Gael has sprung through an opening in the sheep, leaving all but one on one side. Another whistle, another manoeuvre and the rest were sent packing while Gael transfixed the solitary ewe with a gaze which would have put even Bjorn Borg off his serve.

Then Merv began to show off. He gave Gael the command for left and right (come by, away to me) as quickly as he could mouth them. The bitch twisted and turned on the spot like some string controlled puppet. "She's a bit quicker on the whistle," said Merv, whistling his two tunes between his teeth with all the rapidity of a yodeller in *The Sound of Music*. Gael writhed, delighted in her new role of demonstrating her ability to know left and right and move one way and then the other before she had even time to get her front feet off the ground.

There were a few more tricks. But, basically, I'd had enough. It's true. Merv is a bit older than me and started a bit younger—he pushed his first trial in 1947 at the tender age of 15. Since then he's won dog trials every year, seven firsts in one memorable week alone. Merv and Gael gave me plenty to write about. But somehow they have come between me and my dog. No longer can I view the fair Ruscoe in quite the same rosy, perfectionist way that once I did. We look sadly at one another across the breakfast table now. I suppose I've come to realise he might never have won the international championship had I bothered to enter him.

But there was one consolation. Nothing would induce Gael to sit at the feet of her master and have her photograph taken. Ruscoe would sit there all day, with a big smile all over his face. And if truth were told he'd probably sit at anyone's feet all day if they just happened to be holding a packet of crisps in their hand. □

WESTMINSTER SCENE  
Laboratory lobby

Tam Dalyell MP

After the publicity given to the recent break-in at the Institute of Animal Physiology at Babraham outside Cambridge, it was inevitable that the matter should be raised in the House of Commons. David Trippier (Rossendale) asked about the necessity for experiments to be carried out on animals, referring particularly to "a sheep with a plug in its side". Neil MacFarlane, under secretary at the Department of Education and Science, said that the main function of the institute at Babraham is to improve basic knowledge of the physiology and biochemistry of farm livestock. "Some parts of the institute's programme," he said, "involve experiments in animals. Other techniques are used wherever possible." In the experiment mentioned by Trippier, which has aroused much public discussion, the plug was inserted so that the contents of the sheep's stomach could be sampled. This was an essential part of research into digestion, the purpose of which was to increase the understanding of the way in which sheep and cattle feed.

In my view, Babraham and many other institutes and university research departments are going to have to take the offensive and spell out to the press and public exactly what benefit such research brings to mankind, and indeed to animals. People involved in this sort of work cannot suppose that it is sufficient to keep their heads down and say as little as they decently can. In the autumn of 1981, it is virtually certain that the government is going to come forward with its own legislation on animal experiments, as the Home Office Minister of State, Timothy Raison promised during the course of the abortive debates on the Fry Bill in Committee. Since the government will understandably be trying to get popularity in any field it can—not involving considerable amounts of public expenditure—it is only too likely that there will be pressure inside government to appease the so-called "animal lobby" which appears to have considerable public support and many times more votes than the "baddies" who work in or are prepared to stick up for laboratories like Babraham.

The job of the research workers in the next 12 months should be to leave no stone unturned to make sure that the public at large understands that in the absence of their laboratory work, many useful drugs which are taken for granted would simply not be available. I respect anyone who says that animals are as important as human beings, or even more important. That is a point of view to which anyone is entitled, though I suspect that not many of us share it. What I do not respect is the attitude of those who use either violence or extreme language against researchers, while at the same time expecting for themselves and their families all the benefits of modern science.

I recently asked Dr Rhodes Boyson what the government was doing to study the comparative pay of technicians working for universities and those working in industry. The minister told me that a comparative study of the pay of university technicians has been referred to the standing commission on pay comparability, and that a report is expected by the end of July. I put the obvious question—whether he considered that technicians' pay awards should be determined by cash limits, or by pay comparability. Boyson merely responded that he did not know what the report would say. He said he knew my concern, and that it was important that universities had a proper laboratory back-up. "We have tried to hasten the report," he said. "When we have it, we shall consider the matter further."

Going round on visits to universities, I sense that many technicians are getting very restless indeed. Moreover, they are often, though not always, in a position to make a move, since the very skills they have are often related to the bottlenecks that still exist in parts of British industry, even in these days of dramatically increasing joblessness. When the report is published, those working in laboratories might be well advised to contact their local MP, giving him or her an early indication of their view. □

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## What is it they hear?



Sandy Mearns.  
Shell Operator. Aberdeen.

the oilfields far over the horizon. This is the Post Office Telecommunications radio station at Scousborough on Shetland.

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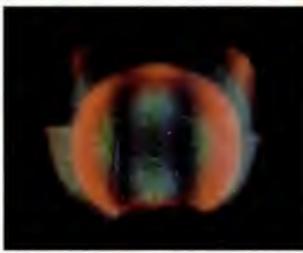
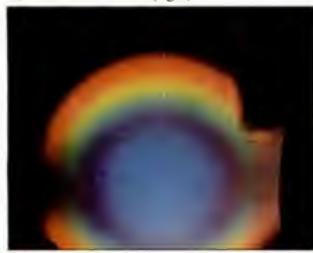
The SRS will help to elucidate the structure of molecules like the enzyme modelled on the right



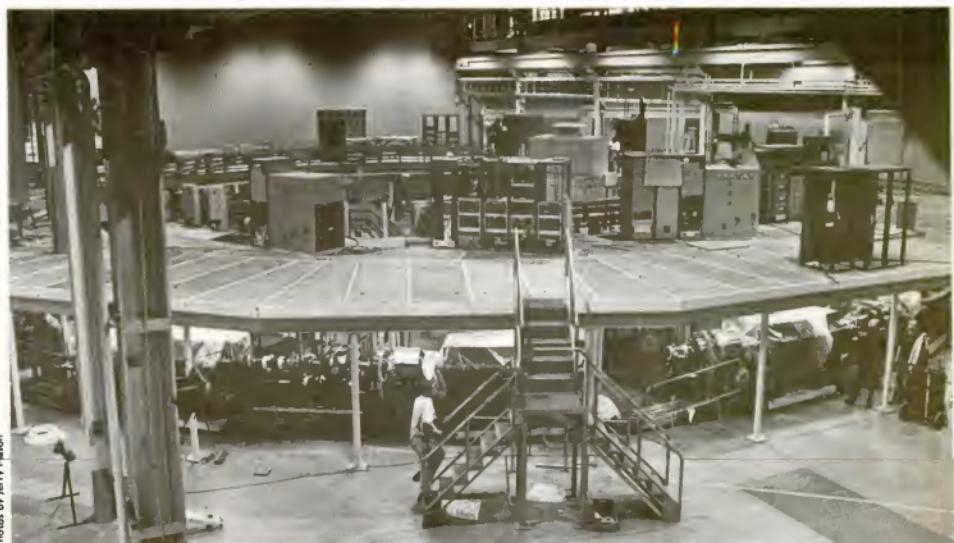
Part of the main storage ring of the synchrotron radiation source—SRS (top). The electrons pass through the centre of this sectional view of a beam tube (above). The complex cleaning-out procedure includes ionising an argon/oxygen mixture inside the tubes to remove carbon atoms from the metal surfaces (right)



Left: David Street, Pike Connelly, Darvbury Laboratory  
Right: Sue Macpherson, Birkbeck College



Soviet physicists working at the VEPP 3 storage ring in Novosibirsk have already built and tested a magnet that can increase the intensity of radiation at the shortest wavelengths by making the electrons "wiggle" around their circular path. When the energy of electrons in the circulating beam is low, this "undulator" produces radiation in the visible region (above). A simpler "wiggler" magnet should be installed on the SRS by next summer



Photos by Jerry Mason

## Daresbury: tunable radiation for research

One of the few large projects Britain's scientists can now afford will soon be ready for work. A ring of whirling electrons will supply electromagnetic radiation to a wide range of experiments ranging across many disciplines. Building the source has cost £13 million—and placed severe strains on government funding for science. In their enthusiasm researchers have forgotten the setbacks...

**Ros Herman**

Almost every kind of scientist, it seems, needs X-rays. Biologists use them to study the structure and function of large molecules, from nucleic acids to proteins; physicists employ them to contemplate the atom; and materials scientists probe the weaknesses of all kinds of materials by seeing how they reflect X-rays when under stress. What research workers would really like is an X-ray source they could tune, like a radio, to produce electromagnetic radiation of useful intensity at any required wavelength. Such a magical source is about to begin operation in Britain. It is the Science Research Council's Synchrotron Radiation Source—the "SRS"—at Daresbury in Cheshire.

Daresbury's SRS is the first in the world designed specifically to supply protons for scientific research. It supplies intense beams of radiation at any wavelength from infrared to hard X-rays (the research worker simply has to select the wavelength he wants) and no fewer than 60 groups of scientists are already queuing for its services. It took five years to build, cost £13 million, and is as big as a football pitch.

The principle of synchrotron radiation is simple. Electrons are hurled around in a circle, guided by magnets: in practice, the electrons move through a vacuum inside a tubular ring, and the magnets are on the outside of the tube. Because the electrons are constantly changing direction they are, by definition, constantly accelerating—acceleration implies change of direction as well as change of speed. As they accelerate they throw out electromagnetic radiation, in front of them in an intense beam, as if shot from a gun. This radiation is thrown out from the whirling

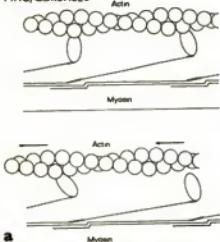
stream of electrons tangentially, like the sparks from a Catherine wheel; and can be tapped simply by putting ports in the ring. The important characteristic of radiation produced in this way—in contrast to that produced from conventional sources, whether they be light-bulbs or X-ray tubes—is that it encompasses a wide and uninterrupted spectrum.

The electrons that supply this valuable radiation at Daresbury reach their rapidly circulating state in four stages. They originate from a hot cathode. Then they are caught and sent on their way—their energy raised to 15 milliontron volts (eV)—by a linear accelerator. Then they are injected into a ring-shaped booster synchrotron where their energy is raised further, to 600 million eV (600 MeV). Finally, the electrons are injected into the central part of the SRS, the main storage ring. After several minutes there are enough electrons in the main ring— $2 \times 10^{12}$  electrons in all—to provide the required current, and the magnetic field and power input are raised to whirl them round at their final energy level of 2 GeV ( $2 \times 10^9$  eV). The storage ring is 30 metres in diameter—more than 100 metres round—and the stream of electrons complete  $3 \times 10^9$  circuits in every second. This moving stream of electrons is, by definition, an electric current; and with the machine at full stretch, the current will approach half an amp. The total energy in the beam is 600 joules—just enough to heat  $1\frac{1}{2}$  litres of water through  $1^{\circ}\text{C}$ . Once established in the storage ring, the current can feed experiments for about 10 hours before needing replenishment.

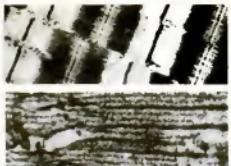
The radiation thrown out in the electrons' paths emerges from the storage ring through round ports cut out of the

**Muscle fibres contain myofibrils lying side by side (above, right). Each myofibril—about 1 micrometre across—consists of units called sarcomeres joined in a chain. When muscles contract the sarcomeres shorten.**

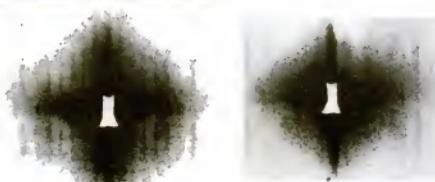
MRC/Cambrid...



Above. Physiologists think that when muscles contract crossbridges that emerge from the myosin filaments interact with the actin filaments lying alongside so as to pull the towards the centre of the actin filaments inwards sarcomere thus shortening the sarcomere's overall length. The diagrams show one way this might work: the crossbridges latch on to the actin filament and pull it along



Inside each sarcomere unit are two sets of filaments (below left). Actin filaments extend inwards towards the centre of the sarcomere from either end. Myosin filaments, lying within the sarcomere but not attached to it, interleave with the actin filaments.



**b**  
*by changing their orientation.*

The X-ray diffraction pictures (taken with a conventional source) show substantial order in the resting myosin filament, which is lost as the muscle contracts (b). The high density of X-rays available from the DORIS storage ring has recently allowed Hugh Huxley and his colleagues to follow in detail the loss of order through many contractions. They have

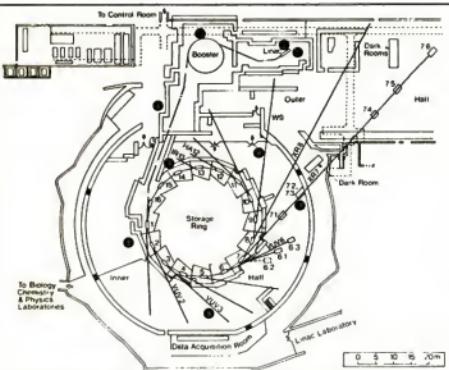


shown, for example, that the intensity of the layer lines (vertical in figures) decreases quickly after the muscle contracts (c) and then rises again more slowly. The cycle—which lasts a few hundred milliseconds—correlates well with the rise and fall of tension in the muscle. An electronic counter measured changes in the intensity of a narrow portion of each time millisecond by millisecond.

ring. Just after it emerges at each port a beam splitter shares the radiation so as to send a portion down each of several "branch lines". The termini of these branch lines is where the radiation fulfills its purpose.

Experimenters arrange to catch the beam on a sample of the material they want to investigate. As the tiny waves weave their way through the material they cause changes among the atoms and molecules, which give rise to new and different waves, just as an obstacle in the path of a sea wave would change its pattern. The altered radiation that emerges from the sample will be recorded, either on photographic film, or as numerical data from an electronic detector. Then the researchers will work backwards from their results to reconstruct just what was happening inside the sample to produce the changes in the radiation that they recorded.

Just like sea waves, electromagnetic radiation can be labelled by a wavelength—the distance between two crests of a wave. Sea waves



In the SRS electrons from a hot cathode (1) take up radio frequency power in a linear accelerator (2) and then a booster synchrotron (3). They pass along a transfer path (4) into the main storage ring (5) where they circulate clockwise. Electromagnetic radiation emerges at the beam ports and travels along beam lines towards experiments. Some beam lines will supply radiation in the vacuum ultraviolet (6, for example); others X-ray (7 for example). During 1981 Daresbury staff plan to install a superconducting wiggler magnet that will produce the highest possible intensities at the smallest wavelengths—1 angstrom and below (8). Radiation at the longest wavelength will come from the infrared port (9).

have a length of some metres, the SRS will produce "waves" that range in length from one-ten thousandth of a metre, or about the size of a human blood corpuscle, down to one-millionth of that length ( $10^{-11}$  metre, less than the distance between atoms in a molecule).

The most interesting range—and the one in which the SRS produces most of its radiation—is that of the shortest wavelengths. Waves up to  $10^{-8}$  metre are X-rays; these are particularly useful, precisely because their length is of the same order as distances between atoms or molecules in many solids and liquids. Suppose the atoms or molecules are grouped into units that are repeated indefinitely at regular intervals throughout, as in a crystal. When X-rays hit the crystal, they will be significantly deviated by the atoms in their path. And the alteration will happen similarly for each unit of the crystal.

The pattern of repeated units causes the waves to interfere in a regular way that produces a fan of discrete rays that emerge from the crystal—the angles that separate them are determined by the size of the repeated unit. The intensities of the rays are modulated by the nature and arrangement of the atom in a repeat unit. Researchers use this "X-ray diffraction" technique to work out structures of molecules they could never hope to "see" in the normal way. This, and other related types of experiment where electromagnetic radiation is systematically deflected, comes under the general heading "photon scattering"—one of the two main categories of research on the SRS.

Although electromagnetic radiation does behave like sea waves, that can be deflected and interfere with each other, it also has one property that has no parallel with waves that move matter. The radiation comes in discrete units, called photons; each photon has a packet of

## X-rays highlight material break-up

Externally imposed stresses cause tiny flaws in materials; synchrotron radiation can be used to form images of the damage by a process called diffraction topography. This uses a radiation of a range of wavelengths ("white radiation") to form a real image of the defects.

Derek Bowen of the University of Warwick and J. Miltat of the University of Paris have recently studied microcreep in an alloy of iron with 3.5 per cent silicon. Working at the Laboratoire pour l'Utilisation du Rayonnement Electromagnétique (LURE) at Orsay near Paris, they made a series of topographs of a thin crystal showing the damage caused by tensile stress applied while the sample was in the X-ray beam.

The portion shown is about 5 by 10 millimetres in area; the crystal is 0.15 millimetres thick. The stress applied while the first topograph was made was 237 megapascals. The experimenters then increased the stress to 248 megapascals and made the second topograph; the third topograph was made after an hour with the stress continuously applied. The series shows slip bands nucleating from the bottom of the

specimen and from surface etch-pits, and gradually growing across the crystal.

Each exposure would have taken about a day to make on laboratory X-ray sets. Using synchrotron radiation at LURE they took just 15 seconds each. Bowen and Miltat hope that when the SRS is at full power they can make such topographs in just one second.

Many projects in materials science at Warwick's Engineering Department will use synchrotron radiation. Bowen and his colleagues are developing new methods of investigating the microstructure of materials and applying these methods to understanding and controlling the mechanical and electrical properties of metals and semiconductors. The extra intensity in the X-ray beam makes it possible for the first time to follow changes as they happen. Shell, Plessey, GEC, Standard Telephone and Cables are among the companies already interested in such research.

Shell scientists will work with Warwick on microanalysis and diffraction techniques for estimating heavy-metal contamination in coal.

Direction of tensile stress ← →



energy associated with it whose size is determined only by its wavelength. Electrons in atoms and molecules are arranged in shells or orbits each associated with a similar, discrete, packet of energy. They can move from one level to another—but only if they can acquire or lose just the right amount of energy. The X-rays from the SRS, and their slightly less energetic neighbours in a region called the vacuum ultraviolet (with a wavelength of  $10^{-8}$  to  $10^{-7}$  metre), have energies ranging from 100 000 to 10 eV. This matches the energy gaps corresponding to many changes between electron energy levels involved in processes that excite atoms or molecules and sometimes initiate more drastic chemical changes. Using the SRS, researchers will systematically work through the X-ray and vacuum ultraviolet wavelength ranges to see what energies excite their samples—and what happens after they have been excited. This opportunity—offered only by a continuously tunable source—has become open only to scientists working in this region of the spectrum with access to synchrotron radiation.

Before such sources were available, scientists interested in both photon scattering experiments, and those who wanted to investigate the quantum nature of matter, would produce X-rays by throwing a stream of fast-moving electrons at a metal target. These moving electrons excite the electrons in the shells corresponding to different energies. As the disturbed electrons fall back, they emit radiation corresponding to just a few transitions between energy levels. So the radiation is concentrated in a few very narrow wavelength bands. Using such sources alone, it is possible to sample the effects of X-rays at only a few points in that wavelength region. A similar problem afflicts the vacuum ultraviolet region of the spectrum.

For such a useful scientific tool, synchrotron radiation

had an inauspicious beginning—as a waste product from accelerators built for particle physics experiments. The synchrotron is a ring-shaped accelerator designed to produce very energetic beams of electrons or protons. As the particles circulate, they give off radiation, as in the SRS. The energy lost by proton beams as synchrotron radiation is hardly significant proportion of the total—but for electrons the energy loss is so large as to be a major limiting factor in determining the highest energy the electrons can reach. (And as far as the particle physicists are concerned, the higher the energy, the more interesting the experiment.)

### Experiments begin in the US

Scientists first used synchrotron radiation in 1955 from the 300-MeV Cornell ring. Over the next 20 years others gradually began to follow suit, in particular at the National Bureau of Standards in Washington DC and the University of Wisconsin. In 1974 scientists in the US obtained their first national synchrotron radiation laboratory—at the SPEAR ring at the Stanford Linear Accelerator Center in California.

Among the first users of SPEAR and DORIS were X-ray crystallographers, who could see the advantages of a continuous spectrum for their experiments. To discover the reason for this, we have to go back to the way X-ray diffraction works. The discrete rays that emerge from the crystal (see above) are recorded on photographic film, or measured by some form of counter. Each can be described completely by two pieces of information. One is its intensity—which is related to the number of photons, or the blackness of the film. The other is its phase—a measure of the difference between waves from different regions of the crystal. To extract complete information about the

way a molecule is arranged in a crystal, scientists need to know both pieces of information. But they can measure only one—the intensity—from the film.

Crystallographers have devised various lines of attack to solve this "phase problem". One way is deliberately to change the pattern of the diffracted waves by introducing a heavy atom into the structure. This contributes to the final wave, which changes its intensity by an amount related to the original phase of the diffracted ray. A different heavy atom will have a similar effect with a slightly different intensity change. The original phase can be calculated from a knowledge of the positions of the heavy atoms and the change in a ray's intensity. Once the phase information is established, the data necessary for reconstructing the positions of the atoms is complete.

Biochemists investigating proteins expect to reap several benefits from a synchrotron source. The enhanced

intensity will allow them to collect stronger reflections in a shorter time. And the damage inflicted on biological molecules by the X-rays is often related to exposure time, not total dose, so quicker application of the X-rays is less damaging.

#### Closer focus on a biomolecule

A crucial enzyme for releasing energy in muscle is the subject of one of the most successful studies of this type. Phosphorylase is the catalyst in the first step of the breakdown of glycogen, the prime source of energy in muscle. Biochemists would like to understand just how the catalyst works—and how it is controlled by the chemical activity of other participants in cell metabolism. Knowing the three-dimensional structure of the phosphorylase molecule should shed some light on what happens at the molecular level.

#### 4.

#### From electron beam to molecular structure



ELECTRONS MOVING IN A MAGNETIC FIELD THROW OFF A NARROW BEAM IN FRONT OF THEM...

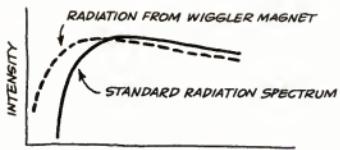


A MONOCHROMATOR SELECTS ONE WAVELENGTH (AT A TIME)...

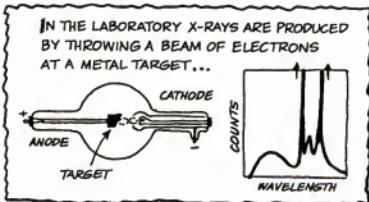
WHICH GOES TO PROBE THE STRUCTURE OF A CRYSTAL...



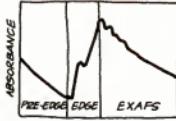
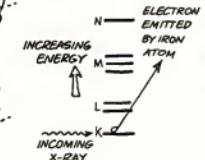
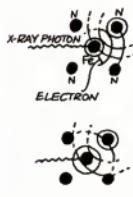
An optical analogue of X-ray diffraction from a crystal. Light rays that pass through the model of one molecule (left) form a diffraction pattern (light and shade, right). The X-ray diffraction pattern from a real single molecule would be much too weak to pick up. But if the molecules are arranged in a regular lattice, some of the diffracted rays from each molecular unit interfere constructively, adding up to a signal large enough to be detected. The resulting diffraction pattern (superimposed in black) samples the diffraction image at a regular lattice of points (represented in the background).



... WHICH IS MADE UP OF MANY WAVELENGTHS AS ABOVE



... OR THE ENVIRONMENT OF AN ATOM ...



An X-ray hits an iron atom, causing it to throw off electrons. The electron, in the form of a spherical wave, will hit a neighbouring atom and be partially reflected back towards the emitter. The interference between forward and reflected waves shows itself as a modulation of the X-ray absorption pattern—hence the ripples—which scientists have labelled "extended X-ray absorption fine structure" (EXAFS). The pattern of ripples yields information about the number, type and distance of the various atoms that surround the primary absorber.

Louise Johnson and colleagues at the Laboratory of Molecular Biophysics at Oxford have been studying crystals of phosphorylase (the *b* form found in resting muscle) using standard X-ray diffraction techniques. In 1978 the group published a diagram showing how the polypeptide chain of phosphorylase is folded, and the relative positions of the 841 amino acids (see Box 5). Johnson and her colleagues worked out this structure—to a resolution of 3 angstroms ( $10^{-10}$ m)—using diffraction data with the most powerful type of conventional source. The time taken to make a film depends on how long it takes to record a measurable intensity of the weakest reflections. They collected no fewer than 18 000 reflections, each measured four times, from the native crystals and from two heavy atom derivatives—to achieve the result.

To make more precise statements about the positions of the atoms, the Oxford scientists needed data to higher resolution. To improve the resolution to 2 angstroms they would have to take no fewer than 60 000 reflections for each set of data. Such an experiment was beyond the scope of their X-ray source and camera: Each photograph (and they needed 90 exposures in all) would take 13 hours. With such a long exposure, the X-rays would have destroyed the crystal before the experiment was complete.

The Oxford team took its crystals to the synchrotron source at the Laboratoire pour l'Utilisation du Rayonnement Electromagnétique at Orsay near Paris. Here the researchers had access to a much stronger beam, and moreover, one which allowed a much larger crystal in the beam. They collected enough data for a structure with 2 angstrom resolution in which each photograph took 6 minutes (see Box 5).

The phosphorylase experiment is one example where synchrotron radiation has made an established technique more effective. But access to such a strong source also suggests refinements that simply wouldn't have been possible before. John Helliwell, who works at Daresbury and Keele University, plans to exploit the fact that with a continuously tunable source scientists can choose the wavelength of incident X-rays to get the most accurate results from the experiments using heavy atoms.

How accurately the phase of the reflection can be determined depends on the size of the intensity change that the heavy atoms bring about as the wavelength is changed. The intensity change peaks where radiation is absorbed preferentially because its energy corresponds to the gap between energy levels of the electrons around the atom. These peaks in the spectrum are called absorption edges. So experimenters could improve their accuracy by choosing wavelengths near the absorption edges.

Some researchers have made preliminary trials of a new approach to use just one form of crystal plus heavy atom,

and take measurements at two wavelengths near the absorption edge. This form of experiment will be particularly appropriate for molecules that can take only one type of heavy atom and for crystals—including so-called metalloproteins: proteins that contain a metal atom—that naturally include one. One such metalloprotein, erythrocruorin, has already been studied this way, although in this instance the experimenters were limited in their choice of wavelength as they didn't have access to a synchrotron.

An exciting prospect for the future is to watch chemical reactions in the crystals as they take place, by monitoring changes on the diffraction pattern. To make this possible scientists would have to cool the sample to slow down the reactions; otherwise the reactions would be too quick to be photographed.

Time-resolved studies of chemical reactions in crystals may be a long way off—but dynamic studies of larger

5.



The complexity of the molecule of glycogen phosphorylase *b* is shown in the diagram (actually the right of a stereographic pair). To arrive at such a structure Louise Johnson and her colleagues at the Laboratory of Molecular Biophysics at Oxford University had to work out positions for each of the 841 amino acid units, each represented here by a carbon atom.

The advantage of the high intensity of the X-ray beam from a synchrotron can be clearly seen in the diffraction pictures: the upper picture was taken with X-rays from a synchrotron in an exposure lasting 6 minutes, while the lower image took 13 hours to make on a conventional X-ray source.

The relationship between the molecular structure and the diffraction image is similar to that indicated by the much simpler pictures described in the bottom left of Box 4

biological systems are on the verge of success, thanks to synchrotron radiation. Hugh Huxley of the Medical Research Council's Laboratory of Molecular Biology at Cambridge has pioneered research into how the protein fibres in muscle interact as the muscle contracts. Huxley and his team use striated muscle—the type responsible for voluntary movement—from the thighs of frogs (see Box 1).

Huxley and his colleagues have combined two new approaches to make diffraction pictures that clearly show the changes in the myosin molecule. First they used the most intense source they could find—the electron synchrotron DORIS at the DESY laboratory near Hamburg—which provides  $10^{10}$  to  $10^{11}$  photon per second—about a thousand times more than a conventional source. Secondly, they set up a counter to record the diffraction pattern over the contraction cycle through many cycles.

In the next series of experiments the team will make

## The SRS - a big project for 'little science'

A few scientists in the UK saw the possibilities of synchrotron radiation very early. When the NINA electron synchrotron opened at Daresbury in 1967 the particle physicists moved in first—but scientists who use X-rays soon came round to scavenge the waste radiation. One of the pioneers was Hugh Huxley, whose work is described in Box 1. Others included Ian Munro, a chemist at Manchester University (now at Daresbury), Geoff Marr, a physicist from Reading University, and Mike Hart of King's College, London.

In 1972 the British scientific community took the painful decision that it could no longer afford accelerators for particle physics: scientists would have to devise experiments to be performed at CERN in Geneva. Not many scientists in the UK used the radiation from NINA, but those that did saw that a continuous spectrum source could benefit a much wider range of experimenters than a high-energy accelerator. And the machine physicists who designed, constructed and maintained NINA formed a pool who could easily convert their skills to building a suitable source. The lab buildings were there, already paid for—and some parts from NINA could even be saved for the new machine.

The Science Research Council circulated a report outlining a proposal for a purpose-built X-ray source in 1974. The authors were clearly conscious of the prevailing trend away from big science: they were at pains to point out that the synchrotron radiation source was a rela-

tively expensive project, to be built as a central facility, but was not big science. "Here we have an example of a case where the evolution of experimental methods in so called 'little science' demands the communal use of costly centralised resources", they wrote, and they listed no fewer than 39 subject areas in physics alone where the X-ray source could make an impact.

The SRS got the go-ahead in 1975, but the five years of construction haven't always been easy. From the beginning, funding restraints have prevented the designers from incorporating all the technical developments they would have liked. The Science Research Council has to limit the number of staff at Daresbury and this, too, has held back the work. Industrial action over pay for government technologists also contributed to the delay.

### Cash problems cause holdups

Most scientists accept these delays; high inflation and tight controls on government spending are facts of life. But others think that the project should have been completed sooner—in two to three years, like the National Synchrotron Light Source at Brookhaven, New York, due to be completed in 1981. The machine has again cost more than expected, and as a result, funds allocated for beam lines and laboratory space, which are essential to make the source worthwhile, have been raided. So the beam lines will come into operation more slowly than was planned—again extend-

ing the building time.

And there may be a shortage of cash for research and equipment grants to make use of the machine. The SRC's Science Board, had to turn down 20 per cent of the top category of research applications this year; several of these would have involved work at the SRS. A few researchers would make an even more fundamental criticism: they would say that access to synchrotron sources in Europe was quite adequate for the research that really needed it—and that the £13 million spent on the SRS should have gone on research in universities.

Yet the gamble seems to have paid off. Today, scientific communities around the world have woken up to the growing demand for synchrotron sources. The SRS will be the first major source of its kind designed exclusively to produce electromagnetic radiation for research. But soon after will come the Photon Factory in Japan and the National Synchrotron Light Source at Brookhaven in New York State. The Brookhaven source has the advantage of certain design developments that will make it a more powerful machine—these came too late to be incorporated in the SRS. The laboratory at DESY, in Hamburg, will be upgraded to include many more beam lines—it will eventually have 30 work stations just for X-rays, about the same as the number of X-ray stations on the SRS. And European scientists are already thinking about building an even more sophisticated X-ray source that would cost around £70 million. □

similar measurements on samples of muscle that have been extended beyond their normal length. The plan is to look at the changes in the X-ray pattern and attempt to relate them to shifts in the orientation of the crossbridges. Some of these experiments may well go on the SRS next year to see whether the X-ray intensity is high enough.

X-ray diffraction can show up the structure of substances, but it's only a secondary guide to the nature of the atoms and molecules present. A tunable X-ray source can also add considerable refinement to routine chemical analyses based on picking out the characteristic spectra of atomic elements. Conventional X-ray equipment allows researchers to identify atomic species and calculate their relative proportions. With a synchrotron source, chemists can go a step further: they can look at the absorption edge (see above) of an atom in a sample and work out the details of its chemical environment. A typical edge (Box 4) can be divided into three regions—the region leading up to the edge, the edge itself, and the ripples that follow the edge. These arise when an atom that has absorbed an incident X-ray throws off electrons. This type of experiment comes into the "quantum interactions of matter" category described above. Scientists call these ripples "extended X-ray absorption structure—EXAFS—(see Box 4). This is a very general technique that can be applied to solids, liquids and gases, formed from not only large but also small molecules.

### The sting in the tail

All these experiments are examples that point the way to what SRS will do. Many of the researchers involved are in fact British: thanks to the hospitality of European and US colleagues they have been allowed to continue their

work until the SRS is finally opened to scientists. But these researchers form a small and privileged core who will pass on their experience to a much larger group.

Those who claim that the SRS should never have been built (see Box 6) are in the minority. But their views may well hint at danger for the future. The Science Research Council is also building another source designed for multidisciplinary use, the spallation neutron source (or SNS) at its Rutherford Laboratory. But to pay for the source, which will cost £44 million, the SRC will have to stop funding research that uses the linear accelerator at Harwell—the only neutron source in the UK suitable for structural research. Some users are understandably irate to see their present work cut off while they wait for the SNS, whose opening has already been put back from 1982 to 1984, again, largely through the lack of funds. And scientists who do not need such expensive equipment, but do require smaller grants for equipment to keep research alive in their university departments are beginning to see projects that involve big capital expenditures as a threat to their future. By the nature of things, the large projects become like lumbering elephants that cannot be stopped when money is tight: the ant-sized individual grants are much easier to chop.

The Advisory Board for the Research Councils seems to have picked up this particular problem in its recent call for a close look at the planning of large capital expenditure in UK science. Worried researchers should be heartened by this. But they shouldn't be too critical of the ambitious and expensive project in general. To admit that we cannot afford such enterprises—either alone or in collaboration with other countries—will be to accept that the UK has become a scientific backwater. □

# Feedback

## Mermaid mummers seek more money

If you happen to think that the country could do with a few more Whittles and Barnes-Wallises, a couple of Cricks and a gross of Medawars, and if you've a million quid to spare, here's what to do. Write out a cheque for that small sum and send it to the Mermaid Theatre down at Puddle Dock hard by Blackfriars Bridge here in London.

It was just over 20 years ago that Bernard and Josephine Miles established the Mermaid in a patched-up, bombed-out warehouse, and the building rapidly became a theatrical shrine. Twelve years ago Josephine had an inspiration and added the Molecule Club, since then more than

a million 7-11 year olds have been enchanted and instructed by a series of rumbustious pantomimes which presented some of the basic truths about light, sound, electricity, and mechanics just as if such dusty school-book subjects were *fun*. And, of course, they are, if only you have the necessary skill and imagination to make them so.

The Molecule Club staged its productions at the Mermaid for short seasons several times a year, whenever they could be fitted in. It also went on tour. But a couple of years ago the Mermaid closed to allow a new theatre to be built around the original warehouse, at no cost because the scheme

cunningly incorporates an office block that will pay for the theatre. And the new Mermaid includes a separate 250-seat theatre expressly for children, where the Molecule Club will be able to do its own excited thing whenever it would like to.

The club will surely continue to inspire the future Whittles and not so on that we need, but not unless you send them that million, because although the building is free the fixtures and fittings aren't. It is to buy those fixtures and fittings that the Mermaid trustees need a million. Not a lot to ask in support of an effort that inspires an interest in science among the very young, and which so happily joins the two cultures in entertainment. □

## It's rubbish, by Jove

Of course it is a free world, and you're welcome to spend your money wherever you choose, but we would suggest that you don't spend it with the advertiser who hides behind Box D482 of *New Scientist* classified ads.



Two weeks ago this person asked "is Jupiter a decayed neutron star?" in our columns, and advised you to check last week's issue. Incensed, two scientists who had been plagued by such notions before now, attempted to place an ad saying, simply, "No it is not!"

Alas, freedom does not extend that far, and their attempt to redress the balance was not permitted by the powers-that-be who decide these things.

And so, last week, there was the follow-up ad offering a "radical new theory for the birth of our solar system". There is no need. The standard theory works fine. But then, so does the advertising department. □

## Beer isn't (so) bad for you

Remember the great beers - you - cancer scandal? Some jumped-up chemist in the US Food and Drug Administration had discovered that a great many beers contained the dreaded nitrosamines—very bad news indeed because nitrosamines definitely do cause cancer. No drinker took any notice but British brewers reacted ferociously because the upstarts in the FDA actually had the temerity to place several of our British beers on their nitrosamine blacklist.

The commercial machine whined into action and the popular press obliged with "Hands off the British Pint" and "Who Cares if we Drink a Tiny Amount of These Funny Chemicals?" Brewers were at pains to reassure the boozing public that such tiny quantities of carcinogen really couldn't do you any serious harm.

Well, put down that pint and prepare for a situation update.

It now seems that all that nationalistic fervour was a little out of place, for the FDA recently tested various brands of beer again and found that practically all of them contained less of the deadly nitrosamines than before. It is, apparently, a simple matter to expunge the offending chemicals by adding sulphur to the barley as it dries. What is more, the brewers say, it costs no more to provide the drinker with a safe pint. Only three of the FDA-tested beers

now contain more than five parts per billion of nitrosamine—the level at which the FDA steps in. And only one of these offending brews is British.

To those of you whose preferred tipple is Samuel Smith's Old Brewery Pale Ale we say, there is no need to fret. The old boy told us that the offending batch went out in February and that since then he has had a clean bill of health, at least from the Food and Drug Administration. □

## Cover artists

Walter Cardew is the artist behind the cover we reproduce below. He and other third-year pupils at Sheen School in East Sheen had to design magazine covers in Art, and their teacher, Eileen Boothroyd, sent us a sample. All were highly imaginative and very entertaining, and we're only sorry we haven't the space to show you more of their covers, and in colour. □



IF INFORMATION IS EMBARRASSING TRY NOISE!



## Non-correction

We've been trying for ages to get the Noise Advisory Council to correct the gross error that made a nonsense of its press release on disco noise and deafness. You will recall (Feedback, 3 July, p 49) that the NAC got its decimal points in a twist and translated a 0.025 per cent risk of deafness into a 1 in 40 000 risk. The true figure is 1 in 4000. Now, a month after the incorrect release, the NAC has trotted out a cover-up that is a two paragraph masterpiece of bureaucratic wording suitable for framing.

To obliterate the error a batch of completely fresh and meaningless figures has been lifted at random from the original incomprehensible report. The only hint of a correction is a parenthetical clause buried among some quite different statistics.

The NAC's purpose is clear, at least to us. Recipients of this garble will dump it forth with into the nearest waste-paper basket and the error will be perpetuated. But whoever goofed at the NAC will be able to declare with clear conscience that a correction has been issued. And the NAC obviously does not want (or is not able?) to hear anything more about the matter—all telephone numbers on the latest press release have been crudely obliterated. □

## Mail fool

Better late than never dept: Did you hear about the fine trick that the American Census Bureau pulled on the Post Office? An informant tells us that the envelope for returning the census form had the address printed on it sideways so that it wouldn't go through the automatic sorting machines. What's more, the envelope was of an illegal size. The forms all had to be returned on 1 April, so apparently the PO was swamped with undesirable mail. □



The theme of the New Scientist/  
British Association Young Scientists  
Essay competition this year is:

# MAN AND SPACE

1980 is an important year for space exploration. Europe's new Ariane rocket is being tested, and the United States is to fly the first reusable Space Shuttle to

carry astronauts and scientists into space. Satellites in orbit around the Earth can show us what the weather is doing, and they can seek out valuable resources from on high.

Spacecraft are sending back to Earth photographs and scientific measurements of the planets. What do you think of all this?

Why do we want to go into space? Is it part of man's desire to colonise the planets? Or is it a waste of money? What would you do in orbit?

Send us up to 1500 words on this theme and you could win one of the following prizes:

£50 for the winner

£25 for two 2nd prizes.

The judges will take the entrants' ages into account. And the results will appear in the 4 September issue of New Scientist. All three winners will be offered bursaries to attend, free of charge, the 142nd annual meeting of the BA at Salford University, 1-5 September. The winners and five runners-up will be given a free subscription for one year to New Scientist and one year's membership of the British Association Young Scientists.

Entries should be typed or written in English, using only one side of the paper and double spacing. On the top left hand corner of the first page give your full name and address and date of birth. Put your name on every sheet. The competition closes on 8 August. The judges will include Michael Kenward, editor of *New Scientist*, and Alec Hughes of BAYS. Post your entry to Pat O'Flanagan, Rm 2637, King's Reach Tower, Stamford St, London SE1.

# Heritage

## In breadth and not in length

Prince of Physicians was the title given to a man born a thousand years ago next month. Abu Ali Ibn Sina—known to the West as Avicenna—was perhaps the most influential of the philosopher-scientists of Islam in its medieval heyday. His book, *The Qanun*, is universally recognised as the most famous single work of its kind in the history of medicine.

Avicenna was born near Bukhara, in what is now Soviet Uzbekistan, in the year 980. His father was a local governor for the Persian Samanid dynasty in Bukhara and the boy grew up at court. He was given a good education and in his autobiography he tells us that he knew the *Quran* by heart by the time he was 10 and then went on to study logic and mathematics. By the age of 14 he found himself ahead of his teachers—he maintains that he was teaching them rather than the other way round—so from then on he conducted his own studies. He wrote: "I desired to study medicine . . . It is not a difficult science and naturally I excelled in it in a very short time so that qualified physicians began to read medicine with me."

By his 18th birthday Avicenna claimed to have "mastered all the sciences". He had been helped in his studies by gaining access to the magnificent library of the Samanid princes of Bukhara as a reward for curing the Sultan of some obscure malady. He then turned to writing. First, it was a compendium for a neighbour; then around 20 volumes on law followed by a book on ethics.

When Avicenna was in his early twenties, the Samanid dynasty fell to invading Turks and he was forced to leave Bukhara. He crossed the desert to Persia where he sought patronage at the court of first one and then another of the princes ruling various provinces of the country. From that time on he led an unsettled life: sometimes in favour at court, sometimes forced to flee for his life. At one time in Hamadan he was even made wazir, or prime minister. Towards the end of his life he settled in Isfahan but in 1037 the city was besieged and he returned to Hamadan where he died of colic at the age of 58.

Despite the ups and downs of Avicenna's life, he managed to turn out an amazing corpus of writings. However, his main claim to fame rests on two enormous books, *The Shifa'* and *The Qanun*.

*The Shifa'* is a vast philosophical and scientific encyclo-

pedia, probably the largest work of its kind ever written by one man. Avicenna's philosophy in *The Shifa'* owes a great deal to Aristotle and to other Greek influences as well as to Neo-Platonism. Essentially he was trying to reconcile the rational speculations of the Greeks with the revealed religion of Islam. He faced considerable criticism because his thought undermined fundamental Muslim beliefs concerning creation and resurrection and after his death there was a general reaction against his philosophy.

It is as a doctor that Avicenna is best known and *The Qanun*—or *Canon of Medicine*—proved his most in-



Mary Evans

Left Physician, philosopher and bon viveur, Abu Ali Ibn Sina—this engraving probably owes little to its subject's true appearance and character

fluential work. It was a fundamental medical textbook in European universities from the 12th to the 17th centuries and it is still studied in parts of the East today. There are five books. The first two deal with physiology, pathology and hygiene, the third and fourth with methods of treatment and the last analyses

medicines and describes their preparation.

In all his work Avicenna constantly threw out provocative ideas and suggested methods of inquiry. Frequently he pointed the way to important discoveries. To take one example, his conception of the eye as an optical instrument started a train of thought which led to the solution by the 16th century Bavarian scientist, Johannes Kepler, of how the image is formed on the retina. His passion for logical, experimental investigation meant that he was often to be found at the start of an important new conception. This is where his influence on scientific thought seems greatest.

Avicenna's memory is revered everywhere by scholars and scientists but in the East he is also remembered by uneducated people unable to read his books. The Iranians still tell stories about his supernatural memory, and his supernaturally acute hearing. In folk memory he appears as a wizard, as someone more than human. This "larger than life" reputation is probably due to his versatility and the intensity with which he threw himself into whatever he was doing at a particular moment. He loved the physical pleasures of life almost as much as his intellectual work. Wine—despite the Muslim prohibition—he found a necessity and his passion for sexual enjoyment is believed to have hastened his death. To those who reproached him he replied: "I want my years in breadth and not in length."

Audrey Wright



A page from a Hebrew edition of *The Qanun* showing a pharmacy; various treatments are also illustrated

# Letters

## Bug business

I read with interest Stephanie Yanchinski's article "Microbes at work—but is the price too high?" (3 July, p 12). It attempted to give a balanced appraisal of biotechnology and its role in the UK economy rather than adopting the fashionable stance of simply proposing that we must have more "biotechnology".

The original idea for a biochemical company came from industry, that is, the parent company of the Whatman Group, and Whatman Biochemicals Ltd was subsequently set up as a joint venture with 50 per cent of the funding coming from the National Research Development Council. Whatman Biochemicals was not in a position in 1974 to make the considerable investment involved in the manufacture and marketing of diagnostic reagent kits.

The board of Whatman Biochemicals has considered a number of expansion proposals since the company was formed, but all these proposals have floundered on the inability of the schemes to generate sufficient profit from the investment involved. This fundamental industrial necessity is often forgotten by the biotechnologists in university and civil service establishments when considering industrial exploitation of research work. The government might consider that by creating a climate for investment it will promote this new industry far more than by interfering directly.

Until the investment climate

is right, biotechnology will not, in my opinion, get off the ground in the UK.

Unfortunately, since the mid-1970s the climate has not been right for investment and current high interest rates, high inflation and poor business confidence does not encourage long-term investment. Even the salvation of large export markets, which has been important to Whatman Biochemicals (greater than 90 per cent of its sales of enzyme products in every year since 1970 have been abroad), cannot now be relied upon because of the strengthening pound.

A further important factor which could hinder the development of biotechnology in the UK, is the gulf which exists between industry and research establishments. In other countries, and particularly in Japan, close links exist between specific companies and universities.

Ideas of commercial significance are directed along a profitable path at an earlier point than is possible, with the "arms-length" attitude in the UK. A consequence of this collaboration is that the cost of development ideas is less in those countries. Unless, and until current attitudes in the UK change, in order to bridge the gap between industry and academia, further ideas will remain unexploited by British industry and research establishments will continue to be dismayed by the poor return their licensing arrangements generate.

T. J. Langley  
Whatman Biochemicals Ltd  
Maidstone

## Unclear debate

Jeremy Bugler lists a number of exceedingly unlikely scenarios for damaging the cans carrying radioactive waste but gives no indication of how the non-volatile fuel carried could lead to any serious distribution of active material ("Nuclear waste through Britain's cities", 26 June, p 406). The idea that one of the carrying vessels should be subjected for a matter of hours to temperatures of 800°C or so in the middle of a big city apparently without anyone even taking enough notice of the situation to play a fire hose on it from a distance seems to me frankly incredible even if it is technically possible to construct an accident in which a second train carrying specially inflammable material should be involved in the same accident.

Equally impossible to accept, is a scenario in which the container vessel could be smashed in a collision. One can imagine a possible crash in which the container was left across a line and in which it was then struck by the engine of another train travelling at high speed. An impacting engine is not, however, comparable with a solid concrete platform. The front of the engine would be crushed by impact so that the force applied to the container would last much longer and be correspondingly less.

Even more importantly, the effects of damage to the container which could allow the cooling water to run out,

or by some means unclear to me could permit the emergence of some fuel elements, are far less serious than would be the effects of an accident occurring in similar impact conditions to any of a number of industrial chemicals, oil fuel, or industrial explosives. It is again impossible to believe that the fuel would be left to heat up indefinitely without attempts to cool it and although the direct radiation from the fuel would undoubtedly make it necessary to evacuate the neighbouring houses there would be enormously more time available before serious injury was incurred than there would be if poisonous volatile chemicals, let alone liquified natural gas or petrol, should be similarly smashed with a resulting splash over a considerable area.

The catastrophic accidents which can and of course will occur from time to time in all of the major technologies have, for the very reason that they would be catastrophic, received enormous care and attention. In practice, as can be seen from the history of the past 50 years or so, far more individuals per year are killed in minor accidents than in the much more carefully studied major ones. I am not suggesting that the carriage of explosives, oil or chemicals should also be banned from passing through big cities. They could, of course, be split up into far smaller quantities and sent by other forms of transport avoiding all towns, but the total of people killed as a result of many smaller accidents would certainly be

## Grimbledon Down



No. 68

# ENIGMA -

## Locker combinations

Robert Eastaway

On the way to school one morning James's friend Richard, who has quite a head for figures, was telling James about the school locker numbers of himself and his two brothers, Peter and Quentin. All three numbers lie between 100 and 1000.

"My number is divisible both by Peter's number and by the difference between Peter's and Quentin's," said Richard, "and Peter's number is Quentin's number with its digits reversed." He then told James by how much Peter's and Quentin's numbers differed and James was then able to work out each boy's locker number.

What are the locker numbers of the three boys?

A £5 book token will be awarded to the sender of the first correct solution opened on Wednesday, 6 August. Please send entries to Enigma No 68, New Scientist, King's Reach Tower, Stamford Street, London SE1 9LS. The Editor's decision is final. The winner of Enigma No 65, Plus and Minus, was M. J. Baggs, of London.

## Plus and Minus

Answer to Enigma 65

-7, 12, -7, -7, 12, -7, -7, 12, -7, -7, 12, -7, 12, -7.

There are 17 integers in the row. 8 successive numbers sum to 1; 11 successive sum to -1.

far greater.

It would clearly be sensible to ensure that nuclear waste, like tanks full of chloride or explosives, should travel in the middle of trains with innocuous and mechanically weaker containers in front and behind them and it would also be sensible to avoid running them at the speeds of advanced passenger trains. Given this, we would do better to settle down to worry about the places in which really large numbers of people are dying now as a result of traditional practices which have not been studied so well as have the novel ones.

J. H. Fremlin Birmingham

## Allopurinol

Jeremy Cherfas in "Drug for muscular dystrophy raises a storm" (This Week, 12 June, p 229) attempts to treat the discussions concerning the use of allopurinol in the treatment of Duchenne muscular dystrophy in an objective light. While I think a reasonable attempt was made to accomplish that goal, I believe the article put the Muscular Dystrophy Group of Great Britain in a somewhat unfavourable light. While £1.3 million may seem a huge amount of money, it is a relatively small amount to

support the research in Great Britain on muscular dystrophy. To imply that it should be spent supporting Dr W. H. S. Thompson, without reference to scientific criticism of the project, is unfair.

Approximately 1½ years ago I had the opportunity of attending a meeting sponsored by the Muscular Dystrophy Group. I was favourably impressed with the excellence and dedication of the group's medical research committee. One must also be made aware of the difficult task of dividing a limited amount of funds between worthy projects that require more funds than may be available. This then becomes a question of scientific excellence and priority. The Muscular Dystrophy Group of Great Britain is one of the finest organisations of its type in the world. I do not think it is well served by intimating that the group, in the words of Dr Thompson, has become "chained to the rock of the incurability of muscular dystrophy and will never set itself free". It may be more accurate to report that the weight of evidence in support of Dr Thompson's claims has not supported a role of allopurinol in the "curability" of muscular dystrophy.

This is the sort of problem

that recurs each time a new magic bullet is presented to the scientific community. It may be revealing to discover the causes and criticisms leading to the "five rejections from British journals". The Muscular Dystrophy Group was cast in an undeserved, unfavourable light by your article.

Allen D. Roses  
Chief, Division of Neurology  
Duke University Medical  
Center  
Durham, North Carolina

## Smear?

Contrary to your report "Clean-up for solvents market" (Technology, 19 June, p 315) we have no intention of closing our tri/peri plant at the end of the decade and we intend to continue manufacture of these products.

First, they will remain in strong demand for key applications in industry—trichloroethylene in metal cleaning by vapour methods and related activities, and perchloroethylene for dry cleaning and textile applications.

Secondly, used properly, so that exposure of operators is at or below the threshold limit value (TLV) of 100 ppm, they have no significant effect on human health. This is confirmed by a wide range of toxicological studies.

We believe that Genklen will gain ground progressively against trichloroethylene in the metal cleaning and formulation markets because its properties result in lower solvent consumption and energy savings with the additional benefit of lower toxicity, which is particularly relevant in cold cleaning applications. It will also replace cold cleaning with flammable solvents, some of which are also more toxic than Genklen.

There is no evidence of carcinogenic hazard from Genklen. Tests done by the National Cancer Institute in the United States where massive doses were fed in corn oil directly into the stomach of rats and mice failed to produce any carcinogenic effects due to 1,1,1-trichloroethane.

Although the work is to be repeated by the National Cancer Institute this is because such high levels of 1,1,1-trichloroethane were used

in the original study as to cause a higher death rate than normally acceptable in such studies. The implication in your article that the second study might reverse the results of the first is misleading. ICI's overall view of the safety of Genklen is based on a review of other reported work including a long term inhalation study on rats at three and five times TLV and which showed no incidence of cancer above the controls.

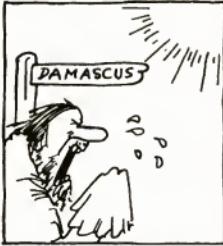
We would also point out that Genklen does not contain acrylonitrile as a stabiliser.

L. Allen  
ICI Mond Division Runcorn

## Atishoo!...

S. W. Widdowson of York wondered why it was sometimes necessary to precipitate a sneeze by looking at a bright light (Letters, 26 June, p 417).

Several reflex actions occur when the eye is suddenly subjected to bright light: the pupil contracts and the lacrimal glands release their salty secretion. The tears pour over the eye and down the lacrimal duct from which



they flow into the upper region of the nasal passages. The sudden arrival of the tears irritates the mucous membrane and triggers the sneeze. This will occur more readily if the mucous membrane is already sensitised because you have a common cold, but it will also occur if, for example, you come out of a dark building into bright sunshine.

Emotional tears do not appear to produce the same effect quite so readily perhaps because the tears are produced in a more controlled and gradual manner. Atishoo. Gerald Legg



## Retort

### Dutch elm disease

The criticisms made by John Benyon ("Dutch elm disease: a catalogue of follies, 3 July, p 20) of the measures taken against Dutch elm disease have already been considered in detail and rejected by the Parliamentary Commissioner in his *Seventh Report for Session 1979-80 (HMSO London, pp 19, £1.50)*. It is surprising that Benyon makes no reference to this report. A summary of the most important steps as they were taken can also be found in successive *Forestry Commission Annual Reports* from 1969/70 onwards.

To deal with the matter fully would need a substantial paper, including comparisons of experience in this field with that of other alien or erstwhile alien pests and diseases such as the Colorado beetle and fireblight of pears and other Rosaceae. A paper including such comparisons will shortly be published by the British Association of Nature Conservators (Phillips, in the press). As so much is readily available in the reports mentioned above I will make only a few comments here.

When dealing with plant health problems the authorities can make their decisions using only the information available at the time, and without the benefit of hindsight. The scale of their operations is also limited by their resources both of money and manpower.

When the present Dutch elm disease epidemic began, the aggressive strain of *Ceratostoma ulmi* was unknown. This key fact would have indicated that we were confronted with what was in effect a new disease, and not Dutch elm disease in the form previously experienced.

Neither the Forestry Commission nor any other body in Britain or elsewhere could have been aware that the new strain was present in North America. This is because the native American elms were all highly and uniformly susceptible to the older, non-aggressive strain of *C. ulmi* (and so no differential effects were visible to American workers studying the disease). In addition, for

some reason not fully known, European elms were relatively unaffected when grown in North America.

Plant health legislation is an international matter and is subject to international agreements, as a result of which legislation is not introduced to prevent the entry of diseases already present. Dutch elm disease has been well established in Britain since before 1927.

With regard to resources, it is by no means true to say that the government made none available. In 1972 and 1973 the Forestry Commission provided £250 000 to assist local authorities, and in later years the government, through the Countryside Commission, supplied grants for disease

of a loss of 13 per cent of the elms in this area, however, dates back to 1976 (when other internal evidence would seem to indicate that Benyon either wrote his paper, or ceased to follow the available literature), and the East Sussex losses have now reached 45 per cent.

The Parliamentary Commissioner, in the report mentioned above, points out that "when some natural disaster of this kind threatens or occurs it is really up to the individuals at risk and the nation as a whole to decide what proportion of their total resources should be diverted from other purposes to that of trying, often with less than certain hope of ultimate success, to avert or mitigate

proved possible to stem the advance of the aggressive strain of *C. ulmi*. Neither were other European countries able to keep this strain from entering their territories although forewarned by our experience.

The points which Benyon raises on the timing of legislation on sanitation felling and on restrictions on the movement of logs, and on the changes which occurred in response to changing circumstances as the campaign progressed are dealt with fully in the reports mentioned above. The reader is therefore referred to this published and readily available material.

Finally, while there is no evidence whatsoever to support Benyon's suggestion that Dutch elm disease can be eradicated, work towards the control of the disease continues. In the more northerly areas some of the elms are slightly more resistant than the English elm which predominates in the south. Towards the north the elms are also less closely spaced, and the climate slows down the activity of the vector beetles. In the south, there is some evidence that with the loss of so many mature elms, beetle populations have fallen, and the millions of elm suckers in hedgerows, though susceptible, are less at risk than in the past. Time alone will show whether they in their turn succumb when they become large enough to provide breeding sites for the scolytid beetles. Observation plots are being used to monitor this situation.

Work is also continuing on new and promising methods of limiting the disease, on the potential for further variations in the pathogenicity of the fungus, and on the selection and breeding of varieties resistant to the disease. Attention must also continue to be paid to the planting of trees other than elms to diversify the countryside and render the overall tree population less vulnerable to attack. The major reasons for the rapid spread of disease in this case were not only the presence of effective vectors but also the existence throughout the countryside of a continuous network of very susceptible trees.

D. H. Phillips  
Chief Research Officer (South)  
The Forestry Commission  
Alice Holt Lodge Farnham



John Storey

control in certain areas. The Forestry Commission has spent substantial sums in surveys of the disease, the organisation of meetings to provide information and advice, the running of courses for local authority surveyors and inspectors, in its continuing research programme and in the preparation and administration of the legislation aimed at the control of the disease. The research councils have also sponsored research using government funds. East Sussex, to which Benyon refers, has waged a relatively successful campaign using its own resources supplemented by funds from the Countryside Commission. Benyon's figure

the dangers feared". Those concerned, the Forestry Commission, the Countryside Commission, the local authorities and others, made the best use they could at the time of the information and resources at their command.

The success achieved in slowing the advance of the disease varied in different parts of the country because in a few areas, like East Sussex, conditions were exceptionally favourable in that the elm population was isolated and an active and vigorous campaign began when disease levels were low, whereas elsewhere this was not so. The same applied in all countries affected by the disease, for in none has it

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recording from invertebrates is essential.  
Salary scale 1A and will run from October  
1980 to September 1983.

Applications, giving qualifications and  
experience and names of two referees, to  
Dr P. L. Miller, Department of Zoology,  
South Parks Road, Oxford, OX1 3PS.

**UMIST**

**POSTDOCTORAL  
RESEARCH ASSISTANT**

REF: MAT/124/AJ. For the successful  
candidate the post is in Theoretical  
Physics which is tenable from 1 October, 1980 and funded  
by the SRC for 2 years. In the first  
instance will be required to work with Dr R. F. Bishop on  
developing the coupled-cluster  
theory and applying it to many-body  
systems and in particular to the  
theory of nuclear correlations and  
bound-state clusters in atomic  
nuclei. Applicants should have  
experience and interests in quantum  
many-body theory or nuclear  
theory, and ideally in both. For  
further information and informal  
enquiries please telephone Dr  
Bishop on 061-236-3311 extension  
2279 or 2189.

Salary will be on the range £5052-  
£6399 per annum.

Requests for application forms,  
quoting the above reference,  
should be addressed to the  
Registrar, Room B4, **UMIST**,  
PO Box 88, Manchester M60  
1QD. The closing date is  
8 August, 1980.

**UNIVERSITY OF OXFORD**

**Department of Engineering  
Science**

**Research in Computer Aided  
Manufacture**

Applications are invited for a post  
of **RESEARCH ASSISTANT** to  
work on a project entitled  
"Computer aided process design  
for cold forging operations".  
Funded by the Science Research  
Council. Applicants should have  
a Honours degree in Engineering  
Science or Mathematics and,  
preferably, experience of computer  
programming and/or metal forming  
operations. The successful  
applicant may be permitted to  
register for a higher degree  
in Engineering in the range £5052 to  
£6399 (under review) plus super-  
annuation.

Further particulars from The  
Administrator, Department of  
Engineering Science, University of  
Oxford, Parks Road, Oxford OX1  
3PJ, to whom applications (3  
copies), including curriculum vitae  
and naming 3 referees should be  
submitted by 1 September, 1980.

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EC4 R YEN.

**UNIVERSITY OF READING**  
**AUDIO-VISUAL  
TECHNICIAN (GRADE 5)**

required for the School of Education,  
London, to provide a technical  
support service to the School.  
Experience of closed circuit television  
equipment essential. ONC or  
equivalent qualification desirable.  
Salary in scale £4257-£4974 per  
annum (under review). Apply for  
further details quoting Ref: TS31A  
to Personnel Officer, University of  
Reading, Whiteknights, Reading  
RG6 2AH.

# COMPUTER VISION

## Research Engineers

### Unique opportunities in new applications of image processing

THORN EMI's Central Research Laboratories in Hayes have long been leaders in "state-of-the-art" technology and our Cognitive Systems Department, has, for the last 10 years, been leaders in image recognition and processing.

The continued success in this research is creating important new activities in this field and in order to expand our programme we wish to recruit talented graduates who are skilled and experienced in both computer hardware and software.

You will be working in small project teams in an exciting technical environment dealing with theoretical algorithm development, real time and simulation software, special purpose digital hardware development plus some analogue electronics. Our hardware includes Data General and DEC minicomputers plus a range of microprocessors and we program in FORTRAN, PASCAL and ASSEMBLER.

Our main requirements are your creativity, enthusiasm, motivation and capacity for hard work. If you also have knowledge of signal or image processing, so much the better.

To apply please write to Neil Robotham, Personnel Department, THORN EMI Ltd., 135 Blyth Road, Hayes, Middlesex or telephone him on 01-573 3888 ext. 3016.

# THORN EMI

CENTRAL  
RESEARCH  
LABORATORIES

### DALHOUSIE UNIVERSITY DEPARTMENT OF CHEMISTRY HALIFAX NOVA SCOTIA

Applications are invited from suitably qualified candidates for a staff position (lecture track) in Physical Chemistry. The appointment is at the Assistant Professor level; however, more senior individuals are encouraged to write expressing their interest. The position, available from 1 July, 1981, is a full-time one. Candidates who may be available from 1 July, 1981 are also invited to apply. In addition to being an excellent teacher, the successful applicant will be expected to initiate a vigorous and innovative research programme. Excellent opportunities for research exist within the Department. Interested applicants should submit a full curriculum vitae with the names of at least three referees, a statement of teaching experience and an outline of current and future research interests to:

Professor W. E. Jones, Chairman Department of Chemistry, Dalhousie University, Halifax, N.S. B3H 4J3. Phone (403) 424-3777.

### RSPCA

requires

### Education Officer (London Area)

Applications are invited from qualified teachers who are also experienced/qualified in biological sciences. Preference will be given to graduates with at least 3 years teaching experience.

Duties include a general responsibility for humane education within the area including visits to educational establishments to speak and advise on various aspects of animal welfare, organising and helping with local fairs, fetes, clubs and involvement with the activities of the RSPCA Junior Membership.

Applicants should be good speakers and able to work on their own initiative. Extensive travelling is required and a current, clean driving licence is essential.

Commencing salary £4626 per annum, together with a Society car and all relevant expenses.

Full curriculum vitae, including full details of any relevant work undertaken, should be addressed in writing to: Staff Relations & Personnel Manager, Causeway, Horsham, Sussex RH12 1HG. Closing date Friday, 8 August, 1980.

### MEDICAL REPRESENTATION

The ethical medical industry places great importance on those whose role it is to introduce and encourage and stimulate interest in their products with pharmacists, GPs and hospitals. A career with great challenge and undeniable interest is offered to people with Science degrees, medical or laboratory background. Thorough training, generous remuneration and substantial benefits are offered and the long-term prospects are excellent.

Phone or write to:  
 Keith Robinson  
**DAVID WHITE ASSOCIATES  
LIMITED**  
 (Medical Recruitment Consultants)  
 54 Kingsway,  
 WC2B 3HG  
 Tel: 01-405 7711



# Chemist/Materials Scientist

## N.W. London

This section of our Vehicle Instrumentation Department is housed in a small, purpose-built unit at Acton, NW10 and is engaged in both R & D and production activities related to solid-state display panels.

We seek a young and dynamic man or woman 25 to 35 years old for a senior position supervising a team of chemists and technicians in fabricating test panels and ensuring that quality control measures are effectively implemented. He or she will be responsible for maintaining adequate facilities for panel production (stock control, equipment reliability, materials inspection etc) in conjunction with the Quality Control Chemist, and for personally assisting in research and development projects at times.

The successful candidate will also undertake specific research projects and ensure the regular testing of new materials, liaising with the Development Chemist, Materials Scientist and Pilot Production as necessary.

Minimum qualifications required are: a good honours B.Sc (Chemistry, Materials Science etc) and ideally an M.Sc in Materials Science or 1-2 years' relevant experience, possibly in the quality control of phosphors or powder technology. Knowledge of vacuum deposition methods, solid state chemistry or screen printing would be valuable.

An attractive salary will be offered, and in addition a full range of benefits. The work location is excellent, with full clean room facilities and the site is near to North Acton Tube Station (Central Line).

Please write with brief details to: D.P. Bagshaw, Personnel & IR Officer, at the address below.



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#### Fed up with the Laboratory Bench?

Medical representation could be the career cure!

If you have a Science Degree (PERHAPS YOU'VE GRADUATED IN 1980) ONC/HNC, or 'A' levels in Science you could become a Medical Representative. We have vacancies for trainees throughout the UK. Salaries up to £5250 + car, + benefits.

You'll have skills in communication and persuasion, and a full driving licence.

For further information and a local interview ring Robert Charlton in Basingstoke. 0256 55955

**Sutcliffe Selection**

9 Victoria Street,  
Basingstoke, Hants.

### AUSTRALIA

#### ROYAL MELBOURNE INSTITUTE OF TECHNOLOGY LIMITED

### SENIOR LECTURER

#### DEPARTMENT OF PHOTOGRAPHY

The Department of Photography offers a B.A. level course in professional photography with a science stream leading to scientific photography and an art stream leading to commercial and advertising photography. The senior lecturer would lead the science stream of the course.

Applicants should have academic qualifications in photographic technology, scientific photography or the equivalent, and have had extensive experience in these fields. Some educational experience would be a decided advantage. Salary within the range \$A22,841 - \$A26,622 p.a.

A position description should be obtained from Staff Branch, RMIT, Box 2476V, G.P.O. Melbourne 3001. Applicants quoting Ref. No. 153-10-AN to the Staff Officer, RMIT by 19/9/80.

21520

### UNIVERSITY OF EXETER

#### Department of Chemical Engineering

##### Enhanced Oil Recovery Research Projects

Applications are invited from chemical/petroleum engineers or others similarly qualified, persons for either of the following posts:

**POSTDOCTORAL RESEARCH ASSISTANT (PDRA)**  
**POSTGRADUATE RESEARCH ASSISTANT (PGRA)**

These appointments are available for two or three years and the posts are superannuable. Starting salaries are £3,200 per annum, £3,725 per annum (£26 (PDRA) or £4400 (PGRA) per annum and are currently under review.

The research will involve experimental and mathematical modelling of miscible displacement processes in porous media at high pressure. The Department is already equipped with facilities for the present phase of the studies and previous work has also included experimental studies of miscible displacement with alcohols at low pressure. The work will likely include the use of supercritical carbon dioxide as a miscible displacing fluid.

Applicants for either post should have a honours degree in an appropriate field, and for the PDRA post, they should have had several years research experience and a Ph.D. degree. A PGRA post may also register for a higher degree.

Further information about the above posts can be obtained by writing to Dr R. B. Turner, Chemical Engineering Department, University of Exeter, EX4 4QF.

Applications (three copies) with particulars of education, qualifications and experience, and the names of three referees, should reach Mrs Doreen Birch, Northgate House, Queens Drive, Exeter EX4 4QJ as soon as possible, but in no case later than 28 August, 1980. Please quote reference No: 7170.

### CITY OF LONDON POLYTECHNIC

#### DEPARTMENT OF PHYSICS

### TWO RESEARCH POSTS

are available for projects in collaboration with major industrial and government research laboratories.

(i) Experimental investigation of coherent and incoherent light scattering from optically inhomogeneous media.

(ii) Preparation and evaluation of Ge(AlAs) single crystal and molecular beam epitaxy (SRC CASE Award).

Both posts require registration for Ph.D. thesis for post (i) within the first year, and for post (ii) within the second year. Date 1 October, 1980. Recent graduates with honours in physical sciences should apply.

For further details write to the Secretary, Department of Physics, City of London Polytechnic, 100 London Wall, London EC2Y 5AZ.

### UNIVERSITY OF LIVERPOOL

Department of Microbiology  
A POSTDOCTORAL SENIOR RESEARCH ASSISTANT

Applications are invited from Professor H. B. Perkins on a project, funded by the Medical Research Council for three years from 1 March, 1981. The project is 'Antibiotic synthesis in *Neisseria gonorrhoeae*'. Initial salary either £5052 or £5389 per annum.

Applications, together with the names of three referees should be received not later than 7 August, 1980, by The Registrar, The University, PO Box 147, Liverpool L69 3BX, from whom further particulars may be obtained. Quote Ref. RV/501/NS.

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It's a new company, a branch of Britain's largest independent computer systems consultancy - and it's expanding fast. That's why their successful team needs more professional consultants in these fields:

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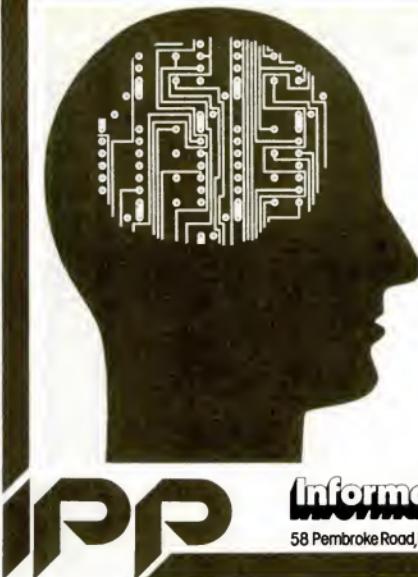
You should be a graduate with at least two years experience in any of these areas and the ability to work with a go-ahead team. You should also be able to communicate, encouraging constant client liaison and negotiation. Salaries range from:

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Where your career's concerned, two heads are better than one.



**IPP**

## Information Processing People

58 Pembroke Road, London W8. Telephone (24 hours): 01-603 7335/6. Telex: 261298

### DEPARTMENT OF ENGINEERING SCIENCE APPOINTMENT OF RESEARCH ASSISTANT IN CRYOGENICS

Applications are invited from Physicists or Engineers preferably with postdoctoral or MSc research experience to assist with the continuation of the development of miniature refrigerators operating at 80K and 4K for cooling satellite-borne infrared detectors. The research is supported by an SRC grant and the post is for three years. Starting salary will be up to £6300 full-time, rising according to age and experience. Applications stating qualifications, experience, age and names of two referees should be sent to the Administrator, Department of Engineering Science, Parks Road, Oxford OX1 3PJ by 18 August, 1980.

### ROYAL POSTGRADUATE MEDICAL SCHOOL MRC Leukaemia Research Unit (Department of Haematology)

**SCIENTIFIC OFFICER**  
required as soon as possible for one year to continue in vitro bone marrow culture studies. Previous experience with culturing stem cells or experiments in haematology desirable but not essential. Applicants should be graduates or equivalent. Starting salary up to £3111 a year.

Application forms and further particulars may be obtained from the Personnel Officer, Royal Postgraduate Medical School, 150 Du Cane Road, London W12 0HS quoting reference number 7/257.

For graduates in engineering, mathematics or the physical sciences: the IEE has vacancies for

## Assistant Editors

At the IEE Publishing Department at Stevenage we publish a wide range of technical journals, learned-society periodicals, books and directories. These are mainly, but not exclusively, for electronics and electrical engineers. We give in-house training in editorial skills and techniques. The vacancies we have at present are particularly concerned with the production of learned journals. However, we carry out a wide range of editorial functions and can offer good potential for further development for a young graduate looking for a progressive career in publishing.

Applications from persons with editorial experience will also be welcomed.

The most appropriate qualification is a degree or equivalent in the physical sciences, engineering or mathematics.

Modern office accommodation, flexible working hours, four weeks' annual holiday, contributory pension scheme, luncheon vouchers and subsidised staff restaurant.

Please write with sufficient details to:

J. D. St Aubyn, Editor in Chief,  
Institution of Electrical Engineers,  
P.O. Box 8, Southgate House,  
Stevenage, Herts SG1 1HQ

### UNIVERSITY OF BATH

#### Department of Biochemistry EXPERIMENTAL OFFICER

Applications are invited from Biochemistry graduates for the above post in the research group of Dr R. Harrington and Dr G. Hunt which is involved with the study of autoimmune diseases of the neuromuscular junction. The post is funded by the Medical Research Group of Great Britain and is specifically concerned with Motor Neurone Disease.

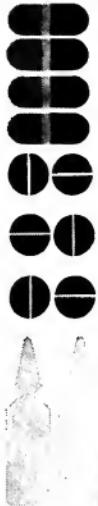
The salary is up to £4185 (under review) for a post of three years.

Application forms from the Personnel Officer, University of Bath, Bath BA2 7AY, quoting reference number 1001, available from 8 August, 1980. For further information, ring either of the above supervisors on Bath 61244, ext 522.

### UNIVERSITY OF READING COMPUTER PROGRAMMER

A graduate with experience of programming in Fortran or Pascal is required to join a team of advisory programmers in the Computer Services Division, including advising research scientists throughout the University on the use of the ICL 1904S, a NORDIC interactive computer system, and remote CDC 7600, as well as developing further software; an interest in electronics would be an advantage. Salary is £2600 per annum (with prospects to £410 per annum). These figures are under review. US £1500.

Apply quoting Ref: R57A, giving details of expertise and qualifications and names of two referees to the Personnel Officer, University of Reading, Whiteknights, Reading RG6 2AH.



# Statistician

## Ware Herts.

Our Computing and Statistics Unit is seeking an additional Statistician to assist in providing a specialised support service for about 500 scientists engaged in pharmaceutical research at our Ware site.

The person appointed will become involved in all areas of drug research and development, including clinical trials. Thus the job offers variety of work and requires contact with scientists from many disciplines.

Extensive use is made of time-sharing computer facilities on the Company's own Prime 400. Systems available include SPSS, GLIM, and, shortly, GENSTAT. The successful applicant will be expected to do some programming in Fortran and, therefore, relevant experience would be an advantage.

Ideally, candidates should be graduates in statistics or Members of the Institute of Statisticians. They should have had a couple of years' experience of applying their statistical expertise to biological or medical problems. Candidates must be capable of working with the minimum of supervision and they must be able to communicate clearly, both verbally and in writing.

We offer an attractive starting salary with participation in Glaxo Group profitability. Extensive fringe benefits include non-contributory pension and, where appropriate, generous assistance with relocation to this attractive area of Hertfordshire.

Please write to or telephone: Dr. D. J. Humphreys, Personnel Officer, Glaxo Group Research Ltd., Ware, Herts. SG12 0DJ. Tel: Ware 3232.

## Glaxo Group Research Ltd.

ST MARY'S HOSPITAL  
MEDICAL SCHOOL  
(University of London)  
Norfolk Place, London W2 1PG

DEPARTMENT OF BIOCHEMICAL  
AND  
EXPERIMENTAL PHARMACOLOGY

Applications are invited for the post of

### Lecturer in Pharmacology

In this Department, the person appointed will be required to teach a comprehensive pharmacology course and to teach a course in experimental pharmacology. Applicants should be graduates in pharmacology or a closely related discipline, with a good honours degree or an equivalent, and should have acquired or be about to acquire the PhD degree. Salary scale £2720-£2944 + £740 per London Allowance. Further written particulars can be obtained from The Secretary, St Mary's Hospital, with applications in the form of a full curriculum vitae with names and addresses of two referees. Applications, in duplicate, to arrive not later than 22 August.

### LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

Keppel Street,  
London WC1E 7HT  
POSTDOCTORAL RESEARCH  
FELLOW

Required for a period of up to three years in the Department of Medical Microbiology to study the role of antigen-antibody complexes in hepatitis B under the supervision of Dr. Steward and Dr. Howie. Preference will be given to honours degree in Biochemistry if essential, and research experience in either protein chemistry or immunology or both desirable.

Salary £15792-£17476 depending on experience and qualifications. For further details contact the above named. Tel: 01-636 8636, ext 292 or 294.

## DEVELOPMENT SCIENTIST

We are looking for a Physical Chemist or Physicist with industrial experience in instrumentation and a working knowledge of gas chromatography and related analytical techniques. The work concerns the further development and production of a mass spectrometer-based pollution monitoring system and will require an understanding of the principles of computerised measurement and control.

Salary commensurate with experience and qualifications; there are generous holidays and an attractive pension scheme. The factory at Winsford is within easy reach of Manchester and residential rural areas.

Contact Tom Ottley on Winsford 52021 for further information and an application form or write to him at VG Gas Analysis Limited, Nat Lane, Winsford, Cheshire, CW7 3QH.



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GAS ANALYSIS

### UNIVERSITY OF GUELPH

DEPARTMENT OF ENVIRONMENTAL  
BIOLOGY

#### PLANT PATHOLOGIST

The University of Guelph has one or more positions in plant pathology available within the Department of Environmental Biology. This multi-disciplinary departmental programme is in agriculture, entomology, plant pathology, applied microbiology and weed science, with thirty (30) faculty and five (5) graduate students. Within the plant pathology there are major teaching responsibilities at both the undergraduate and graduate levels coupled with research and extension work to programmes of the Ontario Ministry of Agriculture and Food. Currently there are eight (8) graduate students in the plant pathology area.

In making these appointments the department is anxious to strengthen its programmes in teaching and in research in the horticultural, turf and field crop areas for which it has responsibilities. The department hopes to recruit plant pathologists with research backgrounds and interested in teaching and in applied and basic research in such areas as biological control, resistance to disease, resistance to disease, virology and pest management. The position(s) will also carry a minor responsibility for extension work.

The appointment(s) will be made at the Assistant Professor level on a tenure track.

Position is subject to final budgetary approval.

Applications should be forwarded prior to 31 December, 1980, to Dr. F. L. McEwen, Department of Environmental Biology, University of Guelph, Guelph, Ontario, Canada N1G 2W1.

COMMONWEALTH  
AGRICULTURAL BUREAUX

Vacancy for

## SCIENTIFIC INFORMATION OFFICER

at the  
COMMONWEALTH SURETY OF  
PASTURES AND FIELD CROPS  
Horley, Merton, Surrey, CR1 3LR

Duties: Scanning field literature dealing with (a) grassland, herbs and fodder crops, (b) annual field crops, and preparing (c) annual reports on the above crops. *Field Crop Abstracts*: Indexing: dealing with technical enquiries.

Working hours: Flexible, 37 hours/week. Qualifications: Higher degree in agricultural or biological science essential. Good reading knowledge of at least one foreign language. Salary: £2300 to £2737 per annum. Starting level according to qualifications and experience.

For further details and application forms, contact Mrs. J. A. C. Clegg, Commonwealth Agricultural Bureau, Farnham Royal, Slough, Berkshire, SL3 3BN. Closing date for applications: 20 August, 1980.

### OXFORD UNIVERSITY

#### ELECTRON MICROSCOPIST

required (part-time) to support the University Reader in Ophthalmology in ultrastructural studies of the eye. The post requires experience with biological material and with histochemical techniques desirable. Candidates should possess ONC or equivalent qualifications and be a Technician Grade 5 (£4257-£4749 pro rata). Hours by arrangement. Applications stating qualifications, age, previous experience and the names and addresses of two referees to be sent as soon as possible to Mr A. J. Bron, FRCS, Nuffield Institute for Ophthalmology, Walton Street, Oxford OX2 8AW (telephone: 0865 48996).

# Environmental Specialists

in: Noise and Vibration      Air Pollution  
Solid and Toxic Waste Management

## Hong Kong

- 25% gratuity on salary
- Low tax area
- Medical/dental benefits
- Free passages

Applications are invited from specialists in noise and vibration, air pollution and waste management for appointment as Senior Environmental Protection Officers to head Sections in the Environmental Protection Unit of the Hong Kong Government. This is an excellent opportunity to join a newly established Unit and to make a real contribution to environmental protection in this dynamic area. Duties will include the organisation and control of on-going monitoring schemes, establishing present levels and future trends of pollution, conducting field surveys and preparing assessments on specific developments that are likely to have significant adverse environmental impact, formulation of legislation, environmental quality guidelines and emission standards, codes of practice and maintaining liaison with Pollution Control Units in Government Departments.

Applicants should have an Honours degree in a scientific or engineering subject from a British university, or equivalent; and 7 years' relevant post-graduate experience.

\*Based on exchange rate H\$11.50 = £1.00. This rate is subject to fluctuation.

**£12,000 p.a.**

- Generous terminal leave
- Subsidised accommodation
- Education allowances
- Holiday visits for children

Particularly relevant experience would be in such fields as notification and control of toxic and other difficult wastes, land reclamation design waste disposal models, automatic methods of air pollution data capture and analysis, air pollution control including modelling studies, engineering design, noise surveys and control of industrial and transportation noise and vibration and rule making.

Preference will be given to candidates who can speak both Cantonese and English.

Appointment will be for an initial period of 3 years. The pay scale for the post is £11,500 to £13,000 p.m. (approx. £12,000 to £13,500 p.a.\*).

For further information and an application form, write to the Hong Kong Government Office, 6 Grafton Street, London, W1X 3LB quoting reference GS/SEPO at the top of your letter. Closing date for return of application forms: 12 August 1980.

**Hong Kong Government**

## Bedford College (University of London)

### Lectureship in Applications of Microprocessors

Applications are invited for a new lectureship jointly funded with the GEC Hirst Research Centre. The lecturer's time will be divided equally between the Research Centre and the College. The educational objectives will be to strengthen the teaching of the applications of microprocessors and microelectronics and to provide a link in this field with industry. The appointment will be made as soon as possible and will be for a minimum of two years with the opportunity subsequently of taking up a full-time post with GEC.

The salary will be within the current university lecturer scale range of £5052 pa up to £10,484 pa plus £470 pa London Allowance, according to qualifications and experience.

Application forms and further particulars from: The Administration Manager, Ref. P/064, GEC Hirst Research Centre, East Lane, Wembley, Middx. HA9 7PP. Tel. 01-904 1262 Ext. 210.

**GEC**

### Safety Evaluation Technologist

Beecham Products Research Department based at Leatherhead is seeking a person with Graduate level qualifications in an appropriate biological discipline to join a small team responsible for the safety evaluation of consumer products.

Applicants, preferably between 25 and 30 years of age, should have several years practical experience in toxicological testing.

This is a new appointment within an established team and the successful candidate will be closely associated with toxicological work on advertised medicines including the development and introduction of new methodology.

Usual large company fringe benefits include non-contributory pension fund, flexible working hours and four weeks holiday.

Applicants should apply giving full details of experience to date to—

Miss E.M. Holland, Senior Personnel Officer,  
Beecham Products, Beecham House,  
Great West Road, Brentford, Middlesex.

**Beecham Products** **B**

# Senior Research Technician for Food R&D

£6100 per annum plus bonuses

Our Research and Development Division is a significant contributor to the successful performance of our well known brands of prepared pet foods including Whiskas, Pedigree Chum, Pal, Bounce and Kit e Kat.

Within the division technicians in the Applied Research laboratories work as part of a team employing many areas of Food Technology from the fundamental science of food ingredients to the formulation of novel, prepared pet foods; all geared to a commercially orientated research programme.

We now have a vacancy for a technician to join a group studying the properties and interactions of the raw materials

**Pedigree**



**Petfoods**

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## THE UNIVERSITY OF LEEDS DEPARTMENT OF FORENSIC MEDICINE

Applications are invited for a post of  
**Research Assistant**

In the above Department to investigate certain aspects of the chemical changes occurring in biological materials over short and medium period. Applicants should be graduates in biochemistry or a related subject and some knowledge of computer programming would be an advantage.

The appointment will be made for a fixed period of up to three years. Salary on the BPS Scale, Research and Analogous Staff £4402-£6399 (under review) according to age, qualifications and experience.

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT, quoting reference number 70/8/E. Closing date for applications 14 August, 1980.

## MRC EPIDEMIOLOGY AND MEDICAL CARE UNIT (Northwick Park Hospital, Watford Road, Harrow, Middlesex HA1 3UJ)

### ASSISTANT STATISTICIAN

Applications are invited for a post to that of an assistant statistician to a prospective study of coronary heart disease and on a large-scale trial of the effectiveness of treating mild hypertension. The person appointed will work closely with both statistical and medical scientific staff.

Candidates should hold a mathematics/statistics degree and should have some experience in programming and an interest in the medical application of statistics.

Initial appointment would be to the post of statistician for a period dependent on age and experience, within the range £4125 to £5017 plus £398 London Allowance.

Applications, with c.v., should be sent to Mr S. G. Thompson as soon as possible.

which might be used in our products and processes. We would like to hear from applicants, male or female, who are qualified to, at least, HNC in biological chemistry, chemistry or food science with previous relevant experience in the food or pharmaceutical industry.

In addition to the starting salary of £6100 per annum, which can rise to £7140, we offer 4 weeks annual holiday, bonuses, non-contributory sick pay, pension and life assurance and generous relocation expenses to this pleasant part of the East Midlands.

If you are interested in this position please write or telephone for a personal history form to Susan Arnold,

Personnel Department,  
Pedigree Petfoods,  
Melton Mowbray, Leicestershire.  
Telephone 0664 4141, extension 4036.

## UNIVERSITY OF THE SOUTH PACIFIC

Applications are invited for the post of  
**CHIEF TECHNICIAN IN  
CHEMISTRY** (Post 80/64)

Appointee will be responsible for all non-academic areas of the Chemistry Discipline, which includes the supervision and training of Technical Staff, the preparation and running of teaching laboratories at Preliminary, Foundation and Undergraduate levels, as well as assisting in research. This work will be done in accordance with the needs of the Chemistry staff but under the general control of the Laboratory Manager. Duties will also include the ordering and stock-keeping of equipment, chemicals and glassware, the maintenance and repair of equipment, teaching and research apparatus and various ancillary duties. Applicants should possess City and Guilds Science Laboratory Full Technological Certificate, HNC or equivalent and have had at least five years in a senior position, preferably in an industrial or research laboratory. Preference will be given to those who have proficiency in instrumentation, electronics, a vacuum technique and a working knowledge of glass-blowing would be an advantage.

Salary scale: £89106-£11189 per annum (1st starting £89106-£90106). The University has a small number of positions within its establishment for which the British Government provides supplementation payments. This post does not carry such benefits and is offered on local terms and conditions only. Gratuity, superannuation, appointments allowances, part-time and accommodation at low rent. Three year contract. Detailed application (two copies) including a curriculum vitae and three referees should be sent to arrive no later than 15 August, 1980, to the Registrar, University of the South Pacific, P.O. Box 1100, Suva. Applicants in UK should also send one copy to Inter-University Council, 90/91 Tottenham Court Road, London W1P 0DT. Further details are available from either address.

# Design JOURNALIST £7700-9300

DESIGN magazine is published monthly by The Design Council. Its object is to provide information and opinion about design to designers and managers in British industry.

The magazine now has a vacancy for an experienced technical journalist with proven sub-editing and production skills.

The successful applicant (male or female) should also be able to interpret economic data relevant to manufacturing industry and make it readily accessible to non-specialist readers. Knowledge of, or an interest in, the process of innovation and the organisation of new product development is an important qualification.

We offer a starting salary on the above scale, there are 5 weeks' holiday and an excellent non-contributory pension scheme.

For further information and an application form please contact Miss Carol Bayley, The Design Council, 28 Haymarket, London SW1Y 4SU. Telephone 01-839 8000 ext 35.

THE

**DESIGN**  
COUNCIL

## UNIVERSITY OF MANCHESTER Department of Histopathology— University Hospital of South Manchester, Withington

### TECHNICIAN (GRADE 6)

required to take charge of new teaching facilities in which no less than 270 University of Manchester students will be taught from September 1980.

Duties will include the supervision of technical staff, the preparation and maintenance of equipment, the preparation and inventory of supplies and equipment; the conduct of a pathology teaching programme, the preparation and maintenance of a CCLTV classroom, the conduct of research and the preparation of reports for the University staff; close collaboration with the Senior Clinical Technician, Department of Histopathology.

Minimum qualifications are HNC, HND, Advanced City and Guilds, Associate or Fellow of ISTM, Associate or Fellow of IMLS, together with 8-10 years laboratory experience.

Salary £4484-£5329 (comparability report 1979/80). Lab. sub-class to review at 1 October, 1980.

### TECHNICIAN (GRADE 4)

The duties of this post will include the provision of teaching laboratories, the preparation of teaching slides and the support of departmental research. Ability to use a CCLTV camera, a video camera, in photography, plastic section techniques, fluorescence microscopy or other relevant biological methodology would be an advantage.

Minimum qualifications are two "A" level, one O.N.C. or Lab. sub-class together with 7-8 years laboratory experience.

Salary £2948-£4454 (comparability report 1979/80). Lab. sub-class to review at 1 October, 1980.

Applications with curriculum vitae and full details of age, qualifications and experience should be sent to Professor D. L. Gershwin, Department of Histopathology, St. Bartholomew's Hospital, West Smithfield, London EC1A 7BE, indicating which post you are applying for.

## FREE-LANCE ABSTRACTORS

A leading scientific publisher requires graduates in Biochemistry, Pharmacology or related disciplines to abstract scientific papers on a free-lance basis. A good knowledge of Russian, Hungarian, Japanese or a West European language would be a distinct advantage (translators are NOT required). A regular supply of work is offered and remuneration is good. For further details and Application Form, please write to: The Director, Derwent Publications Ltd., Literature Division, 168-173 High Holborn, London WC1V 7AA.

## QUEEN ELIZABETH

COLLEGE

Kensington

(University of London)

## TECHNICIANS GRADE 2B

Three technicians are required, one in the department of Chemistry, one in the department of Food Science and one in the department of Physics. Duties include the preparation of materials and the care and servicing of apparatus. Candidates should have ONC, "A" levels, City and Guilds or equivalent and experience of laboratory work. Salary on the scale £4161-£4629 per annum (under review) inclusive of London Weighting.

## TECHNICIAN GRADE 4

required in the department of Physics. Duties include the day-to-day organisation and running of teaching laboratories and the maintenance and construction of apparatus. Candidates should have ONC, "A" levels, City and Guilds or equivalent and experience of laboratory work, preferably in physics teaching laboratories. Salary on the scale £4728-£5325 per annum (under review) inclusive of London Weighting.

All the above posts have holidays of 39 days per annum, and a five-day week. Applications, writing to: The Secretary, Mrs. J. Staight, Queen Elizabeth College, Campden Hill Road, Kensington, London W8 7RH, giving age, qualifications, experience and the names of two referees. Closing date: 8 August, 1980.

## QUEEN MARY COLLEGE

University of London

## ELECTRONICS ENGINEER

Applications are invited for the newly created post of Electronics Engineer, to provide a wide ranging advice and design service to research groups in the Physics Department, including: Astrophysics, Far Infrared Instrumentation and High Energy Physics. The Department has been designated one of two College centres of advanced work in electronics and further responsibilities and opportunities are expected to develop in consequence. Applications are expected to have experience in analogue and digital techniques and minimum qualifications of IEng or Electrical Engineers or a degree in Physics or Engineering. Salary on scale £5052-£6769 per annum (under review), plus £740 London weighting, plus £100 for age/experience. Please apply by letter, giving age, qualifications, experience and names of two referees, to: The Secretary (NS), Queen Mary College, Mile End Road, London E1 4NS.

## UNIVERSITY OF READING

## POST-DOCTORAL

## RESEARCH FELLOW

required for fixed period of two years to work on the Spectroscopy of Molecular Ions using Ion Cyclotron Resonance and Laser techniques with Prof. G. W. Parker and Dr. M. J. Tinker in the Physics Department. Applications are sought from physicists or physical chemists with a wide experience in laser spectroscopy of molecules. Starting salary up to £5725 per annum (interim), US\$ 10,000 per annum, plus quarterly superannuation, plus £1000 per annum R.S.A. with curriculum vitae and names of two referees to: Personnel Officer, University of Reading, Whiteknights, Reading RG6 2AH.

## BIOCHEMIST OR CHEMIST

with broad background of bio-research, including experience in isolation of enzymes etc. required for new research programme. Applications, including background and experience, should be made to: Chief Research Chemist, Synthite Ltd, Ryders Green Road, West Bromwich.

# Molecular Biologist

## for Process Development

Following the expansion of our Fermentation Development Department, an opportunity has arisen for a molecular biologist to join multidisciplinary teams working on the development of commercially viable processes for the production of antibiotics and other microbial products.

Improving the productivity of producer organisms is central to the achievement of this objective and the successful candidate will be involved in the application of modern molecular biology concepts to a number of projects concerned with improving strains of bacteria and fungi.

Candidates must be well qualified, innovative and capable of working closely with staff of diverse scientific backgrounds.

Beecham offer a competitive salary allied to excellent fringe benefits, including non contributory pension and life assurance schemes and assistance with relocation expenses will be given where appropriate.

If you are interested please write or telephone for an application form to:—Mr A. D. Caws, Section Head, Personnel, Beecham Pharmaceuticals, Clarendon Road, Worthing, West Sussex BN14 8QH. Telephone Worthing (0903) 39900, extension 233.

**Beecham**  
Pharmaceuticals

## PHYSICIST ELECTRONICS

For many years we have been in the forefront of research into instrumental methods for the measurement and control of food manufacturing processes.

Much progress has been made and we are now seeking a PHYSICIST to augment our research team and particularly to assist in the investigation of novel measuring techniques using modern electronic devices.

The successful candidate will have a good Honours Degree with some industrial experience in instrumentation but above all an enthusiasm to work in this comparatively unexplored area of R&D.

Starting salary from about £4400 to £6000 depending on experience with excellent career prospects.

Applications please, with brief CV, to:

Mr J. A. Henry, Leatherhead Food Research Association, Randalls Road, Leatherhead, Surrey. CR1 3AF.

## UNIVERSITY OF

SOUTHAMPTON

BIOCHEMICAL AND  
INSTRUMENTATION  
TECHNICIAN

Applications are invited for an appointment as a technician in biochemical and instrumentation technical support for the Physiology/ Pharmacology Group in the School of Biochemical and Physiological Sciences. The post is for a person who will be responsible for providing specialist biochemical support for research and postgraduate training. The post requires relevant experience and knowledge of basic biochemical instrumentation, including spectrometers, centrifuges, recording equipment etc. An interest in electronics would be an asset.

Minimum qualifications for this appointment are Science ONC or equivalent, or equivalent with appropriate experience, but applications from candidates with a degree and research experience in Biochemistry will be welcome.

The appointment date will be from 1 September or as soon as possible thereafter, with a salary on grade 4 salary scale £3948-£4548 per annum (under review). Starting salary in accordance with qualifications and experience.

Applications giving date of birth, details of qualifications and experience, and names and addresses of two referees, should be sent to Mr C. N. Saul, The University, Southampton SO9 5NH quoting reference number 404/1.

ST GEORGE'S HOSPITAL  
SW17

## RESEARCH TECHNICIAN

(Two-year appointment) required for Department of Virology for a project investigating the molecular epidemiology of hepatitis B infection in the neonate. Previous experience in microbiology and radio-immunoassay techniques would be useful.

Salary: £4614 plus £396 London weighting per annum in the first year.

For further information, please contact Professor H. Stern, Virology Department, on 01-672 1253 Ext 4813.

Application forms are available from Mr B. Sorrell, Administrative Assistant, St George's Hospital, Blackshaw Road, Tooting SW17 0QT. Telephone: 01-672 1255 Ext 4121.

Closing date: 2 August, 1980.

ROYAL FREE HOSPITAL  
SCHOOL OF MEDICINE

(University of London)

## A SENIOR TECHNICIAN

is required to work in the Department of Physiology which is situated in the Clinical Sciences Building at Hampstead. Experience of cardiovascular, neurophysiological and/or electro-physiological techniques is essential.

Salary on scale £5801-£7538 (inclusive) under review. Thirty-four days annual leave including Bank Holidays, 37-hour weeks. Interest free annual season ticket loan scheme.

Application forms are available from the School Secretary, RFH, 33 Hunter Street, London WC1N 1BP or telephone 01-837 5385 ext 10. Closing date: 6 August, 1980.

## ALLEYN'S SCHOOL SE22

## BIOLOGY TECHNICIAN

is required for September. Duties include some general science. Up to £2000 is available for suitable applicant. A term time only post would be considered. Apply by letter within 10 days to the Senior Science Master, stating qualifications and experience.

# Environmental Ergonomics

**£5500-£8000**

**Burton-on-Trent**

An opportunity exists to join a large multi-disciplinary group of scientists in a wide ranging programme of ergonomics in the coal mining and other industries. Staff are expected to contribute to all parts of the programme, but experience in lighting and vision would be beneficial. Technical facilities and support are outstanding and a close liaison between engineering design and field users is maintained.

Candidates, with a formal qualification in ergonomics or an allied subject, should have relevant experience of a wide range of ergonomics activities.

The Ergonomics Branch of the Institute of Occupational Medicine is located in Burton-on-Trent and is centrally located for communications, housing and amenities. Conditions of service are excellent and the salary will be in the range £5500-£8000, depending on experience.

Please write with full details to:



**Area Staff Manager/Secretary,**  
**National Coal Board,**  
**Green Park, Greenend, Edinburgh EH17 7PZ.**

## BOTANIST GRASSLAND PRODUCTIVITY—SUDAN

A botanist is required to undertake a study of grassland production in the flood region of the Southern Sudan. Candidates should have extensive experience in the measurement of grassland productivity. Experience of tropical African botany and an ability to live and work under isolated and difficult conditions would be additional recommendations. The appointment will be for 16 months from 1st October 1980, with a period to be spent in Sudan. Applications, with names of two referees, should be sent by 15 August to Dr D. M. Jones, Royal Botanic Society, London, Regent's Park, London NW1 4RY from whom further details may be obtained.

## CHELSEA COLLEGE University of London Biological Sciences Group

**TECHNICIAN GRADE 2B**  
required in the General and Systematic Section of the Biological Sciences Group. Interesting and varied work dealing mainly with undergraduate student requirements.

Salary £4164-£4629 per annum inclusive (under review).

Application forms and further particulars available from Mr R. C. Redmond, Superintendent of Laboratories, Biological Sciences Group, Chelsea College, Hortsensia Road, London SW10. Tel: 352-5778, ext 58. Closing date: 8 August, 1980.

## ELECTRON MICROSCOPE/ MICROPROBE TECHNICIAN (GRADE 5)

required in Department of Geology, University of Reading to operate and maintain a variety of electron microscopes. Good practical experience essential. Salary in scale £4257-£4974 per annum (under review). Apply for further details to Personnel Office, University of Reading, Whiteknights, Reading RG6 2AH, quoting ref. TS10A.

## THE UNIVERSITY OF AUCKLAND

New Zealand

Chemical and Material Engineering

### LECTURESHIP/SENIOR LECTURESHIP

Closing date: 30 September, 1980  
Applications should be academicallly highly qualified chemical engineers able to contribute to at least one of the following research areas: Aspects of Transport Phenomena, Separation Processes, Alternative Energy Sources, Biochemical Engineering, Pulp and Paper Science, Extractive Metallurgy, Materials Science. Applications from those suitably qualified in other areas will be considered. Preference will be given to a candidate well qualified to teach chemical engineering design.

Commencing salaries will be determined in accordance with qualifications and experience. Present salary scales for Lecturers: NZ\$15 149- \$18 615 per annum; Senior Lecturers: NZ\$19 063- \$21 837 per annum. Conditions of Appointment and Application for all positions are available from the Assistant Registrar (Academic Appointments), University of Auckland, or from the Federation of Australian and Commonwealth Universities (Appts.), 36 Gordon Square, London WC1H 9AP. Applications in accordance with "Modern Application" should be forwarded as soon as possible but not later than the closing dates stated.



**Southampton  
THE  
UNIVERSITY**

### DEPARTMENT OF OCEANOGRAPHY

#### Lecturer in Marine Plankton

Applications are invited for a temporary lectureship (minimum two years). Candidates should have postgraduate training in marine plankton or other zooplankton or phytoplankton.

The person appointed will participate in teaching courses on primary productivity and zooplankton. Salary will be on the scale £5025-£10 474 per annum (under review).

Further particulars may be obtained from Mrs E. G. S. Searle, Staffing Department, University of Southampton, Southampton SO9 5NH (from April 1980, the United Kingdom), should be sent including curriculum vitae and the names of two referees by 14 August, 1980, quoting reference 1311/A.

## ANALYTICAL ASSISTANT

A vacancy has arisen in the Analytical Section of our laboratory situated in Basildon, Essex, for an Assistant to carry out routine analysis of a wide range of raw materials used in cosmetics manufacture. The work involves mostly manual techniques. Some familiarity with IR and UV Spectra is desired. A suitable candidate would have some industrial experience and be in possession of ONC (Chemistry). The person appointed would be encouraged to continue their studies for higher qualifications.

Please write or telephone for an application form to:

Mrs A. Cosgrove, Personnel Officer, Yardley Manufacturing Limited, 4 Miles Gray Road, Basildon, Essex. Basildon 22711 ext 106.

# YARDLEY

Staffordshire Area Health Authority

## SENIOR BIOCHEMIST

Applications are invited from suitably qualified candidates for the post of Senior Biochemist. The Clinical Chemistry Department, re-housed in 1972, provides the usual routine services for the Mid Staffordshire Health District. Whitley Council Conditions of Service and Salary apply.

For further information, application forms and to arrange to visit the Department please contact Mr J. H. Michel, Department of Clinical Chemistry, Stafford General Infirmary, Foregate Street, Stafford ST16 2PA. Telephone Stafford 58251 Ext. 66. Closing date 29 August, 1980.

**Mid Staffordshire  
Health District**

## THE LONDON HOSPITAL MEDICAL COLLEGE (University of London)

### RESEARCH TECHNICIAN

Applications are invited for the post of Research Technician within a small team investigating the physical chemistry of connective tissue and wound management which is supported by the MRC. The project requires careful quantitative chemical measurements, and candidates should have the "A" levels, including Chemistry and Maths "O" level. Previous laboratory experience and/or HNC or similar, an advanced technical or similar diploma related to qualifications and experience will be £3711-£4263 per annum.

Enquiries to Dr A. Maroudas, Tel: 01-247 5484 ext. 421. Applications to the Secretary, The London Hospital Medical College, Turner Street, London E1 2AD quoting reference RTBJU/2/80.

## Anglo-Australian Observatory

# ELECTRONICS ENGINEER

The Anglo-Australian Observatory operates a 3.9m optical telescope that is one of the largest and most modern in the world, at Siding Spring near Coonabarabran, NSW, 450km north-west of Sydney, Australia. At a laboratory in Epping, a suburb of Sydney, a small electronics group is involved in developing new astronomical instrumentation and monitoring outside contracts. We are seeking an electronics engineer to participate in the design and construction of a high resolution infrared spectrometer and to assist in the other work of the laboratory.

**LOCATION:** Epping, with visits to other institutions and the telescope.

**DUTIES:** Adapt existing low noise analogue circuits to the multi-channel spectrometer, design a suitable multiplexer and CAMAC interface and participate in the construction, testing and commissioning of the final instrument. Generally assist in other areas of the electronics laboratory, including technical negotiation and monitoring of contracts for the construction of instruments and participation in the commissioning at the telescope.

**QUALIFICATIONS:** An acceptable degree in electronics with some experience and proven ability in both analogue and digital design.

**SALARY:** Within the Experimental Officer 1-2 classification ranging from A\$11 429 to A\$18 381 pa

**CONDITIONS:** Tenure for 2 to 3 years. The Observatory will pay return air fares for appointed and family to Sydney and will assist in the cost of removal of furniture and effects. Rental allowance will be available and superannuation will be offered.

**APPLICATIONS:** Write giving full particulars of education and experience as well as personal details, and including the names of three referees, to reach the Director, Anglo-Australian Observatory, P.O. Box 296, Epping, NSW, 2121, Australia, by 22 August, 1980.

## QUEEN ELIZABETH HOSPITAL

Department of Medical Physics and Biomedical Engineering

# MEDICAL PHYSICS TECHNICIAN GRADE IV

Applications are invited for the post of Medical Physics Technician Grade IV in the Radiotherapy Section of the department which is responsible for sealed sources, moulds, simulator and treatment planning. The successful applicant will be chiefly concerned with the simulator and treatment planning for which a PDP 11/40 computer is in use, but will be encouraged to broaden his interests. Candidates should possess an ONC, HNC or an equivalent qualification.

Salary according to qualifications and experience.

Further information may be obtained from:

Dr A. L. Bradshaw (021-472 1311 ext 366) or from Medical Physics Office, Queen Elizabeth Hospital, Edgbaston, Birmingham B15 2TH.

**CENTRAL BIRMINGHAM  
Health District**

BIRMINGHAM AREA HEALTH AUTHORITY (Teaching)

# Assistant Engineer

## National Planning

### LONDON

up to £10,437

British Gas is currently undertaking a substantial expansion of engineering projects to meet projected demand.

Our engineering programme planning is centred at Headquarters, where we now require an Assistant Engineer, male or female, to make a significant contribution to this planning function. The work entails liaison with our Production and Supply Division and other HQ Divisions on the progress and implementation of general engineering policy and acting as co-ordinator during the planning phases of engineering projects, through Regional contacts. You will also be expected to contribute an input to a wide range of engineering studies and analyses.

To qualify you should be an engineering graduate or equivalent and probably a corporate member of an engineering institute, with several years experience in a technology-based industry. An appreciation of financial (costing) analysis and of computer application to planning would be valuable.

Commencing salary will be in the range of £9,125 to £10,437 and benefits are those normally associated with a large progressive organisation.

Please write with details of age, qualifications and experience, quoting reference PS/63340/741/NS, to: Senior Personnel Officer [London], British Gas, 59 Bryanton Street, London W1A 2AZ.

**BRITISH GAS**

# Research and Development Chemist

North London

c£7,000

Our client is a leading manufacturer of Industrial Consumables and a subsidiary of a major UK-based international group. In order to maintain their reputation for the design of technically advanced products they are expanding their Research Department.

Candidates should be graduates and have at least three years experience in a Manufacturing or Process Industry. A knowledge of Polymers would be particularly relevant.

Telephone Martin Keating on 01-235 7030  
Ext. 233. PER, 4/5 Grosvenor Place, London

SW1X 7SB. (Answering  
service out of hours 01-  
235 6938)

**PER**  
Professional & Executive Recruitment

Applications are welcome from  
both men and women

# Health Physics & Safety at Work-

## A professional challenge for Technologists & Engineers

Nowhere is technology developing more quickly than in the field of Defence. Ensuring a safe and healthy environment for its continued evolution is a science which must keep pace.

The Ministry of Defence seeks high-calibre Technologists or Engineers who will be trained to develop and implement a wide range of health and safety services including biological monitoring, body monitoring, radiological support and emergency inspection.

At the Atomic Weapons Research Establishment at Aldermaston activities cover a wide range of technological services including: Health physics, radiological protection, reactor and nuclear safety; Occupational, toxicological, chemical, explosive and industrial and general aspects of safety and hygiene; Environmental and public safety; Safety evaluation and hazard assessment; Safety training; Analytical chemistry and physical measurement; R&D associated with health and safety activities.

Other opportunities are at the Institute of Naval Medicine, Alverstoke, and at HM Dockyards at Chatham, Rosyth and Devonport

where the successful candidates' responsibilities will include: radiochemistry, dosimetry and instrumentation; watching brief on new developments; providing authoritative advice including training and inspection and the provision of comprehensive health physics services in an industrial environment.

To qualify for this exacting work, candidates (men and women) should normally have a degree, preferably with honours in a relevant subject or be corporate members of an appropriate professional institution, and must have at least 2 years' professional experience. Specialist training will be given. Starting salary between £6100 and £8100 depending on qualifications and experience. Promotion prospects. Non-contributory pension scheme.

For further details and an application form write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours). Please quote ref: T/5131/11.

### ROYAL POSTGRADUATE MEDICAL SCHOOL (University of London)

Cardiovascular Research Unit  
COMPUTING IN  
CARDIOLOGY

An experienced computer required to take charge of all aspects of computing in Cardiology working with both Cardiology staff and physicians experienced in the use of computers and electronics in medical research. HP1000 system and Data General HP3000 system available.

Applicants should have a background in scientific programming, especially in statistics, together with experience in real time applications.

Salary between £7000 and £10 000 a year, initial placing dependent on experience.

Application forms and further details are available from Personnel Officer, Royal Postgraduate Medical School, 350 Queen's Gate, London SW7 2AZ. Quoting reference number 2/502.

### UNIVERSITY OF ASTON IN BIRMINGHAM

Computer Centre  
SENIOR LECTURER

Applications are invited for a Senior Lectureship in the broad area of data processing, systems analysis and design and information systems. The successful applicant will be required to make substantial contributions to the research, supervisory and teaching programmes in this area at both undergraduate and post-graduate levels. Candidates should preferably hold a higher degree and have experience with small (mini or micro based) systems would be an advantage.

Competing salary will be within the range £10 142-£12 564 per annum. Appointments are normally to the first point of the scale. Salaries are currently under review.

Application forms and further particulars may be obtained from the Staff Officer (quoting Ref No: 4/24/80), University of Aston, Birmingham B4 7ET (Tel: 021-359 3611, ext. 201). Closing date for the receipt of applications is 15 August, 1980.

### UNIVERSITY OF STRATHclyde

Applications are invited for a

## RESEARCH ASSISTANT

with polymer training and/or experience in the DEPARTMENT OF PURE AND APPLIED CHEMISTRY, financed by the South of Scotland Electricity Board. The work involves the study of polymers to be used in devices to operate by remote control. The post will be particularly suitable for candidates with some knowledge or experience in the moulding of thermoplastics. It will be particularly suitable for candidates who have an MSc or PhD degree of an instructional or research course on the subject.

Appointment for one year on Range IA of the national salary structure for research and analogous staff. Commencing salary up to £5725 per annum with placing according to qualifications and experience. Superannuation benefit.

Applications (quoting R35/80) with curriculum vitae and names of two referees should be sent to Professor B. J. C. Ladd, University of Strathclyde, Department of Pure and Applied Chemistry, Thomas Graham Building, Glasgow G1 1XL.

### PLANETARY NEBULAE AND THEIR CENTRAL STARS

RESEARCH ASSISTANT IN  
ASTRONOMY

The Science Research Council is supporting a project at University College London over two to three years, on the interpretation of observations of planetary nebulae and their central stars. Applications are invited for the position of Research Assistant and should be sent to Professor M. J. Seaton, Dept of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT.

The work will be concerned with observations obtained in the ultraviolet using IUE, and with relevant observations in the visible and other wavelengths. Its aim will be to obtain information about properties of the central stars, physical conditions in the nebulae, and chemical compositions of the nebulae. It is hoped it will lead to an improved classification of these objects and to a better understanding of their nature and evolution.

Salary in range £5052-£6736 plus £740 London Allowance according to qualifications and experience.

### UNIVERSITY OF READING

Department of Microbiology  
RESEARCH ASSISTANT

required from 1 October, 1980, for a fixed period of three years to work with Dr M. T. Heydem on the physiology and microstructure of fuel fungi. The objectives of the project, funded by the Admiralty, are to ascertain the mechanism involved in hydrocarbon uptake in fuel fungi and to investigate other aspects of the physiology and microstructure of them. Applicants should have a good honours degree in Microbiology or Biochemistry. Registration for a higher degree is possible. Starting salary £5052 per annum (interim), US\$ superannuation. Apply, quoting Ref: RS8A, with curriculum vitae and names of two referees to Personnel Officer, University of Reading, Whiteknights, Reading RG6 2AH.



Weddel  
pharmaceuticals  
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## MICROBIOLOGIST

to be responsible to the Quality Control Manager for the sterility testing of the complete range of sterile products and for the controlling and testing of the environment in which products are manufactured. Applicants in the age group, 25-35, must have a qualification in microbiology, or bacteriology and considerable experience in monitoring the necessary bacteriological control for sterile production areas. Hours 9 a.m. to 5 p.m., Monday to Friday. Pension scheme, subsidised canteen, 4 weeks holiday. Applications to:

WEDDEL PHARMACEUTICALS LTD.,  
Red Willow Road, Wrexham Industrial Estate,  
Wrexham, Clwyd LL13 9PX



SURREY  
COUNTY COUNCIL

North East Surrey College of Technology  
Department of Biological Sciences

Applications are invited for post of:

## Research Assistant

to work on the regulation of C<sub>1</sub>metabolism in *Pseudomonas* AM1.

The post is supported by the SRC for three years. Salary will be on the scale £4539-£4650-£4776.

Applicants should preferably have a degree or MIBiol in Microbiology or Biochemistry. The successful applicant may be able to register for a CNAA higher degree.

Applications in writing, giving details of qualification and experience and the names of two referees should be sent to Dr P. Goodwin, North East Surrey College of Technology, Reigate Road, Ewell, Surrey KT17 3DS, from whom further details can be obtained.

## Assistant Scientific Officers

Home Office Forensic Science Laboratory

Aldermaston, Reading, Berkshire RG7 4PN

Interviews will be held shortly to fill vacancies in the above laboratories.

The Forensic Science Laboratory provides scientific aid to the Police in the investigation of crime and to the Courts in the prosecution of offenders. This involves the examination and analysis of a wide range of materials using specialised techniques and modern chemical, biological, physical and serological methods.

Assistant Scientific Officers are trained in these analytical techniques to assist Court-going staff and they will be responsible also for the care and maintenance of apparatus and the preparation of reagents.

Minimum qualifications:-

For Officer posts: O' level or equivalent, including English Language and a science or mathematical subject; or ONC or equivalent. Only 'O' level passes Banded A, B and C will be accepted for Summer 1975 or subsequent examinations. 'A' levels or equivalent in scientific subjects would be an advantage.

Age at least 16 and normally under 26 on 31 December, 1980.

Assistant Scientific Officers are encouraged to take advantage of facilities for further education and to study for higher qualifications.

Salaries £12,122-£3238 according to age, rising by annual increments to £4030. (Salaries are under review).

Four weeks annual leave.

Registered disabled persons will be considered.

Apply in writing by (10 days after last publication) to The Director, Home Office Forensic Science Laboratory, Aldermaston.



*Home Office*

## INSTITUTE OF CANCER RESEARCH

### A POSTDOCTORAL RESEARCH FELLOW

is required at the Chester Beatty Research Institute, Fulham Road, London SW3, to join a team investigating the chemical, biochemical and biological aspects of the metabolic activation of the carcinogenic polycyclic hydrocarbons. Appointment: Grade 6, £13,200 per annum for up to three years. Starting salary in the region of £7525 per annum plus London Allowance of £740 per annum.

Applications in duplicate, with the names of two referees to the Secretary, Institute of Cancer Research, 34 Square Place, London SW7 3NU, quoting Ref 300/G/25.

### TECHNICIAN (GRADE 3)

required in Department of Microbiology, University of Reading, to prepare, store, supply materials for classes and to assist group engaged in research on an aspect of microbiology. Previous experience essential. Interest in photography an advantage. Salary in scale £3594-£4092 per annum (under review). Apply with full details of experience and qualifications and names of two referees quoting Ref: TS23A to Personnel Officer, University of Reading, Whiteknights, Reading, Berks RG6 2AH.

### ANIMAL HOUSE

### TECHNICIAN (GRADE 3)

required in Animal House of Departments of Physiology and Biochemistry and of Zoology, University of Reading, to work with a variety of species. IAIAT desirable, plus three years industrial experience. Salary in scale £3594-£4092 pa (under review). Apply with names of two referees and full details, quoting Ref: TS41, to Personnel Officer, University of Reading, Whiteknights, Reading RG6 2AH.

## Head of Toxicology & Reproductive Studies

£10,000 NETT  
FRANCE

Our client, a Major International Research-Orientated Pharmaceutical Company, is establishing a new purpose built Toxicology & Reproductive Studies Unit in central France, to be operational in 1982. Your duties will be to recruit, develop and lead a small specialist team engaged in the peri- and post-natal investigations and teratology studies in animal species.

You should hold a higher degree in a Biological science or Medical discipline and will have several years experience of controlling a small team engaged in Fertility, general reproductive and/or Teratology Studies. You should also be totally familiar with GLP regulations. A working knowledge of French would be advantageous but is not essential. In addition to the nett salary of approximately £10,000 per annum, there will be a benefits package valued at approximately 25% of salary.

For further information, telephone -

R. D. LORD on CARDIFF (0222) 23286, or write to him at P.E.R., 4th Floor, Pearl Assurance House, Greyfriars Road, Cardiff, CF1 3AG.

Applications are welcome from both men and women.



## SCIENTIST FOR REGULATORY AFFAIRS IN RESEARCH

The Company is creating a new post in Agricultural Research and Development which offers the opportunity for an experienced scientist to pursue a career away from the bench. Guidelines for Good Laboratory Practice (GLP) are being drafted worldwide and we wish to ensure that our research complies with appropriate requirements.

A meticulous approach to the work is essential and the ability to assimilate information and to communicate clearly with scientists and managers in a variety of disciplines is essential. The person appointed will be responsible for Quality Assurance work as required and will devise, introduce and maintain an archive. There will be a need to assist with the registration of products as necessary and for this a knowledge of a foreign language would be an advantage.

Candidates, male or female, must have a relevant degree, at least three years industrial experience, preferably in agrochemical research. A post graduate research qualification is desirable. Own transport is essential for which a mileage allowance is paid.

Company benefits include profit sharing, contributory pension and staff purchase privileges. Generous help with relocation to the Nottingham area is available if applicable.

Write or telephone for an application form from:- Tom Flower, Employment Manager (Technical), The Boots Company Ltd, Station Street, Nottingham, NG2 3AA. Nottingham 56255 Ext. 243.

### UNIVERSITY OF BRADFORD BIOLOGICAL SCIENCES

#### (a) RESEARCH ASSISTANT (Ref RA/B/BSRC/NSI)

#### (b) TECHNICIAN (Grade 2) (Ref T2/B/BSRC/NSI)

#### Fixed Term Appointments

Applications are invited for the above posts which are funded by a grant supported on SRC funds. Study into organic biogenetics in control of plant development will include a study of membrane assembly, protein phosphorylation and the isolation of membrane proteins. The Starting salary - Research Assistant - £4400, Technician - £4800. Applications are invited for higher degree for suitably qualified candidates.

Further particulars and application form from the Registrar, University of Bradford, Bradford 10P, Closing date 28th August, Interview date 29th August. Tel (0272) 33466 Ext 2222.

### UNIVERSITY OF EXETER POSTGRADUATE RESEARCH ASSISTANT

A Physics graduate is required to work on a low temperature experiment to investigate the new phenomenon of slow propagation of high power waves in liquid helium. The grant is for three years and it is possible to register for a PhD.

Starting salary is £4402 per annum (under review).

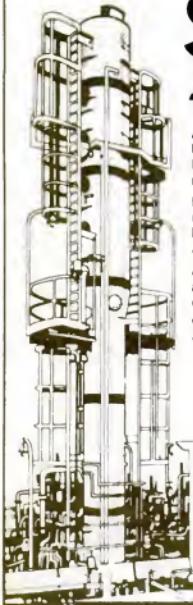
Applications including a curriculum vitae and the names of two referees should be sent to Professor A. G. Wynn, Physics Department, Stocker Road, Exeter EX4 4QL, by Monday, 11 August, 1980.

### BUREAUTECH (SCIENTIFIC STAFF AGENCY)

Top jobs for: ONC/HNC/HND; AMLT BSc; (Chem; Phys; Biol; Med; Lab. subjects; Electronics and Metallurgy.)

Immediate vacancies for Paint, Ink and Surface Coating Technologists. We find you the job free of charge. Tel: 01-966 0251.

# Section Head Analytical Development



As a result of a recent re-organisation within our Quality Assurance Department, applications are invited for the above position at the Irvine factory, Ayrshire, which produces bulk pharmaceutical materials for use in our successful range of semi-synthetic penicillins.

Reporting to the Quality Assurance Manager, the job holder will be responsible for directing the activities of the analytical development laboratory: the main duties include the assessment of new techniques and analytical examination of process problems.

Applicants, male or female, must be Honours Graduates in pure or applied chemistry, ideally with a minimum of 3-5 years Post-Graduate experience.

We offer an attractive salary and generous fringe benefit package which includes:

- ★ Non-contributory pension scheme
- ★ Free life assurance
- ★ Four weeks annual holiday
- ★ Staff bonus after qualifying period
- ★ Assistance with relocation where appropriate.

Written application, enclosing brief career details, should be made in the first instance to the Personnel Manager, Beecham Pharmaceuticals, Shewalton Road, Irvine, Ayrshire KA11 5AP Scotland.

**Beecham  
Pharmaceuticals**

**THE UNIVERSITY  
OF LEEDS**  
**DEPARTMENT OF  
MECHANICAL  
ENGINEERING**  
**POSTDOCTORAL  
RESEARCH FELLOW  
(TWO POSTS)**

Applications are invited for two posts of Postdoctoral RESEARCH FELLOW within the combustion group in the above Department. Applicants should hold a D.Sc. or D.Sc. equivalent research experience.

Each post is available for a fixed period of up to three years.

The holder of one of the posts will work on a project supported by the SRC, which involves laser-doppler studies of explosive turbulent gaseous combustion. The other post is concerned with an SRC supported project involving studies of continuous stratified combustion and the mathematical modelling of it.

Salary on the IA Scale for Research and Analogous Staff, £5052-£8769 (under review), according to age, qualifications and experience.

Informal enquiries about the posts may be made to Professor D. Bradley (Telephone 0532 31751 ext. 242).

Application forms and further particulars may be obtained from the Registrar, The University, Leeds LS2 9JT, quoting reference number 69/6/E. Closing date for applications 11 August, 1980.

## IMMUNOLOGIST

The Company has a large well established research group which investigates the biochemical and immunological aspects of chronic inflammatory disorders, especially rheumatoid arthritis, with the objective of developing new and more effective drugs. We are now seeking to expand the group's studies to include immunomodulatory drugs for the treatment of a wider range of disorders.

Applications are invited from graduates with a first degree in Biochemistry, Cell Biology or Immunology and post graduate experience could be an advantage.

Based in our Nottingham laboratories this is an excellent opportunity for a person with initiative and ability to actively participate in an expanding area of the Company's research programme.

As well as an attractive salary, Company benefits include profit sharing and staff purchase privileges. Generous help with relocation to the area is available if applicable.

Please write or telephone for an application form from:- Tom Flower, Employment Manager (Technical), The Boots Company Ltd., Station Street, Nottingham NG2 3AA, Nottingham 56255 Ext. 243.

## THE UNIVERSITY OF SYDNEY

### LECTURESHIP IN COMPUTER SCIENCE

Applicants should have a higher degree and equivalent qualification in Computer Science. Background in some aspect of AI desirable.

The Department is equipped with a VAX-11/780 and several mini-computers, and provides access to the University's Cyber 170/730 computer. It offers courses in Computer Science from first-year to honours level, followed by MSc and PhD programmes. Appointees expected to teach and carry out research.

Position is expected to be filled by probationary appointment of three years capable of leading to tenure but if all University's requirements for tenure are not met, tenure may be granted at time of appointment. Applications for fixed-term appointments also considered.

Salary range: \$A17 024-\$22 364 per annum.

Further information available from Head of Department, Professor J. M. Bennett in the University.

Applications including curriculum vitae, list of publications and names of three referees, by 29 August, 1980, to Registrar, University of Sydney, NSW 2006, Australia, from whom further information available. Information available from Association of Commonwealth Universities (Appts), 36 Gordon Square, London WC1H 0PF.

**HILLINGDON HOSPITAL,  
UXBRIDGE, MIDDX (777 beds)**

### MEDICAL LABORATORY SCIENTIFIC OFFICER in BIOCHEMISTRY

Applications are invited from persons holding an Honours in Medical Laboratory Sciences or suitable degree for the above post. The laboratory provides the routine diagnostic services for a large District General Hospital and Local Practitioners. It is equipped with modern automated analysers and carries out a wide variety of investigations. Opportunity to study for FIMLS and participation in on-call rots.

Salary £4523-£6215 p.a. inclusive.

Laboratory may be visited by arrangement with the Chief Medical Laboratory Scientific Officer (Uxbridge 38282 Ext. 228) or by post from Personnel Offices Ext. 353.

Closing date 14 August, 1980.

### ORNITHOLOGIST

The British Trust for Ornithology has a continuing need for an Ornithologist at Scientific Officer level, to analyse Common Birds Census returns, assist in the organisation of field work by Trust members, and participate in the research of the Populations and Surveys Section. A good degree, ability to relate to amateur Ornithologists and willingness to lecture are essential for this post. Salary scale is £3591-£4586 pa (under review). Applications with curriculum vitae and names of two referees should be sent to C. W. N. Plant, BTO, Beech Grove, Tring Herts HP23 5NH by 8 August, 1980.

### WANTED

#### A RESEARCH ASSISTANT

Graduate in Biochemistry with some experience in protein separation methods, especially Column Chromatography. Previous knowledge of enzymes and energy metabolism an advantage. Contact Dr P. Dandona, Royal Free Hospital, London NW3 2QG. Tel: 01-794 0500 ext 3481 for further details.

**UNIVERSITY OF NOTTINGHAM MEDICAL SCHOOL**

Department of Biochemistry  
Queen's Medical Centre  
Nottingham NG7 2UH

POSTDOCTORAL ASSISTANT TO work on an MRC financed project for three years starting on 1 October 1980, with Dr R. J. Mayer, "Mechanisms of Protein Degradation: studies on mitochondrial proteins". The work will involve studies *in vivo* and *in vitro* of the regulation of the degradation of specific immunolabelled proteins and resolved organelle sub-compartments of populations. Experience in immunochemical or tissue culture techniques would be advantageous. Applicants should write to Dr R. J. Mayer at the above address giving the names of two referees.

**CHELSEA COLLEGE**  
University of London

**POSTDOCTORAL SCIENTIST**

Applications are invited for a post supported by the National Kidney Research Fund to work with Dr D. J. Butterworth on the regulation of phosphate transport in the kidney. The appointment will be for two years from September 1980. Salary will be in the range of £5792-£6653 (including £740 London Allowance). Previous experience of working with isolated cell preparations and/or incorporate training would be advantageous, but not essential, for gaining the position. Any enquiries regarding the post to Dr D. J. Butterworth (Tel: 01-351 5408, ext 542).

Application forms from Personnel Officer, Chelsea College, Friese Greene House, Chelsea Manor Street, London SW3 3TW. Closing date: 11 August, 1980.

**NUFFIELD INSTITUTE FOR MEDICAL RESEARCH  
UNIVERSITY OF OXFORD**  
(one year contract, Home/Europe rate)  
MEDICAL LABORATORY SCIENTIFIC OFFICER (Grade C12)

An experienced scientist is required for studies on the regulation of metabolism in and the differentiation of developing testes. The postholder will be involved in the development of biochemical mechanisms relating to the control of metabolic pathways. Experience of a wide range of techniques used in a biochemical laboratory is essential.

Applicants should be estate registered MSc or overseas equivalent, or a science degree or equivalent qualification together with at least two years relevant laboratory experience.

The post is available from 1 September, 1980, and salary is £2000. Council MLSO scale £4615-£5017 per annum.

Applications stating age, qualifications and giving names and addresses of two referees should be sent to: The Administrator, Nuffield Institute for Medical Research, Headley Way, Headingley, Oxford OX3 9SB.

**UNIVERSITY OF CANTERBURY**

Christchurch, New Zealand  
Applications are invited for the following position:

**LECTURER IN ZOOLOGY (PARASITOLOGY)**

Applicants should be qualified to do and carry out research in Parasitology. The University is seeking to employ a Lecturer with broad training and experience of parasitic animals.

Applications for the above positions close on 31 August, 1980.

The salary for Lecturers is NZ\$15 149 to \$18 615 per annum.

Further particulars and conditions of appointment may be obtained from the Administrator of Commonwealth Universities (Appts), 36 Gordon Square, London WC1H 0PF.

**RESEARCH OPPORTUNITY  
WITH RENTOKIL**

**Young graduate chemist**

required for the development of timber preservatives from project initiation to commercialisation.

Candidates should have (1) a good honours degree in chemistry, or combined honours with chemistry as one of the subjects, (2) preferably good formulation experience and determination and enthusiasm to succeed in industrial R & D.

Salary in the range of £3900 to £5500 pa according to age, experience and qualifications. A full UK driving licence is essential.

**Write or telephone for an application form to:**  
**Miss S. Edwards, Rentokil Limited, R & D Division, Felcourt, East Grinstead, West Sussex RH19 2JY. Telephone (0342) 833022.**

**THE CITY UNIVERSITY**  
Centre for Information Science

**Research Fellow or  
Research Assistant**

(Statistics and Computing)

Applications are invited for the above post, for work on a project concerned with the design and testing of information retrieval systems based on probabilistic principles.

The person appointed will take charge of setting up and maintaining a suite of test programs, and will also investigate appropriate statistical methods.

The ideal background would be a degree in statistics and computing, and some research experience. A knowledge of document retrieval systems would be useful but is not essential.

The appointment is for one year from 1 October, 1980, at a salary within the range £5052-£5399 plus £740 London Allowance (Research Fellow) or £4402-£5399 plus £740 London Allowance (Research Assistant).

For further details contact Dr S. E. Robertson, Centre for Information Science, The City University, Northampton Square, London EC1V 0HB (01-253 4399 ext. 231 or 556).

**University College Hospital**

**BIOCHEMIST**

Biochemist to work in the Department of Haematology on the antenatal diagnosis of Thalassaemia and related areas. Salary Scale £4205-£6473.

Enquiries about this established post should be made to Professor Huens on 01 387 9300 Ext. 614.

**Application forms from and returnable to the Personnel Department, University College Hospital, Gower Street, London WC1 or telephone 01 387 9300 Ext. 381  
8 August, 1980.**

**THE ROYAL VETERINARY COLLEGE**

University of London

Division of Paraclinical Studies  
Department of Microbiology and Parasitology

**RESEARCH ASSISTANT**

Applications are invited from good honours graduates, preferably with research experience in biochemistry, microbiology or parasitology, for the above post available from 1 October 1980, for work in collaboration with Dr P. H. Russell on a new 3-year project under a grant from the Wellcome Trust. The successful candidate will be required to register for a higher degree with the University of London.

The project involves an analysis of the envelope proteins and virulence of Newcastle Disease Virus by using monoclonal antibodies and other techniques.

**INITIAL SALARY:** £5142 including London Allowance (Grade 1B). Superannuation under the universities' scheme.

Application form from Assistant General Secretary (Personnel), The Royal Veterinary College, Royal College Street, London NW1 0TU (Tel: 01-382 2898).

**BEDFORD COLLEGE**

(University of London)

**RESEARCH TECHNICIAN**

required for work in Regent's Park on the development and construction of equipment needed for research in solid state physics and other duties in the Department of Physics. Applicants for this Grade, established post should have had sound training in manipulative skills and a willingness to apply them in relation to the novel techniques required. Preference will be given to those with some post-training experience.

Gross salary range £5037 to £5754 per annum; 38 days total holiday per year including statutory holidays. Season ticket loan scheme.

Applications to the Senior Assistant Secretary (Personnel), Bedford College (University of London), Regent's Park, London NW1 4NS, (Tel: 01-466 4400, ext 312). Further particulars are available.

**THE LONDON HOSPITAL MEDICAL COLLEGE**

(University of London)

Department of Chemical Pathology

**RESEARCH ASSISTANT (GRADE 1B)**

required in the Steroid Laboratory to work on the estimation of vitamin D and its metabolites in plasma using GC-MS and HPLC. Applications should hold a BSc in Biochemistry and there is a possibility of registering for a higher degree. Salary £4402 plus £740 London Allowance per annum.

Enquiries to Dr H. L. J. Makin, Tel: 01-247 0644, ext 7172. Applications to The Secretary, The London Hospital Medical College, Turner Street, London E1 2AD, quoting reference CP/7/80.

**TECHNICIAN (GRADE 3)**

required in Plant Science Laboratories, University of Reading, to assist in running media preparation, unit, batch and microbiological teaching/research. Duties include operation of large automatic autoclaves and mixed-bed demineralisers, water treatment. Minimum qualification ONC or equivalent plus two years relevant experience. Salary in scale £3594-£4062 per annum (increasing review). Applications in writing, quoting Ref: APL40A, to Personnel Officer, University of Reading, Whiteknights, Reading RG6 2AH.

## Fuel Technologist

We have a vacancy in the Fuels Group of our London based Design Department for an Engineer or Chemist, preferably qualified to degree level in Fuel Science/Chemical Engineering/Chemistry and with practical experience in the energy field, to assist in all fuel and combustion aspects of steam generator design.

The job includes fundamental studies of fuel types, their categorisation, the determination of their effects on the design of furnaces and boiler ancillaries and taking part in presentation and discussions with prospective and existing customers at home and abroad.

The successful candidate will be offered an excellent employment package and assistance given with relocation where applicable.

Please telephone or write to, Mr D M McLaren, Administration Officer, quoting Ref 12B, for further details:—Babcock Power Limited, 165 Great Dover Street, London SE1 4YB. Telephone: 01 407 8383 Ext 663.

## Babcock Power Limited

**IMPERIAL COLLEGE**  
(University of London)  
Computer Centre  
**MICROCOMPUTER CENTRE**  
SUPERVISOR/  
DEMONSTRATOR

Required to assume responsibility for setting up a new Microcomputer Centre, arranging for its use, and planning for software and training support.

The post offers a challenge for someone with interest in both software and hardware, and provides an opportunity for involvement in the management of microcomputer development in the college. The successful applicant will be required to collaborate with other college laboratories in providing support for all aspects of microtechnology in teaching and research.

Salary will be commensurate with age and experience in the range £5720-8340, inclusive of London Allowance. Further details and application form from Dr R. J. Hunt, Computer Centre, Imperial College, London SW7 2BX. Tel: 01-589 5111, ext. 1197.

**ROYAL FREE HOSPITAL**  
**SCHOOL OF MEDICINE**  
(University of London)

TWO JUNIOR TECHNICIANS are needed to work in the Department of Physiology which is situated in the Clinical Sciences Building at Hampstead. The successful candidates will assist with research work and teaching duties. One of the posts requires experience of an interest in histology.

Salary on Valley Training Scale. Three hundred hours, week 35 days annual leave including Bank Holidays, etc. Interest free annual secondment scheme.

Application forms are available from the School Secretary, RFHSM, 8 Hunter Street, London WC1N 1BP, or telephone 01-837 5385 ext 10. Closing date: 8 August, 1980.

## Staffordshire Area Health Authority

### SENIOR MLSO in Clinical Chemistry

Applications are invited from suitably qualified persons for the post of Senior MLSO in the recently (1972) re-housed Department of Clinical Chemistry at the Staffordshire General Infirmary, Stafford. Participation in Clinical Chemistry on-call service.

Further information and application forms may be obtained from Mr M. A. Mitchell, Chief MLSO, Stafford General Infirmary, Foregate Street, Stafford ST16 2PA. Telephone Stafford 58251 Ext. 66. Closing date 29 August, 1980.

## Mid Staffordshire Health District

**IMPERIAL COLLEGE**  
**GEOLGY DEPARTMENT**  
(APPLIED GROCHEMISTRY  
RESEARCH GROUP)

### INSTRUMENTAL ANALYST (Grade 5)

An enthusiastic chemist/technician required for duties in geochemical research laboratories, including use and supervision of up-to-date spectroscopic equipment (ICP and automatic AAS). Minimum of A-level chemistry required and suitable experience. Salary (under new pay scale) £5420-£6050 per annum.

Post-appointment: There is a generous sick pay scheme. The working week is 37½ hours, 5 weeks annual holiday plus several days in addition, public holidays at Christmas and Easter. There is a modern staff canteen and social club, together with sports centre and swimming pool. Season ticket loan scheme after six months.

Application forms from Mr J. R. Blounds, Departmental Superintendent, Geology Department, Imperial College, London NW3 6RB. Tel: 01-435 2232. Please quote reference number VP/114. Closing date for applications: 15.8.1980.

## TECHNICIAN

to be responsible (under supervision) for a laboratory engaged in maintaining all stocks and supplying cultures to use within the Research Division. Applicants must have had wide experience in all culture work and possess an HNC or equivalent.

The institute is situated in pleasant grounds close to Hampstead tube station. We have a staff canteen and an active social club.

Salary on Technician Scale: £4676-£6125, inclusive of London Weighting. Starting salary will be dependent upon age and experience.

Please write or telephone for an application form to the National Institute for Biological Standards & Control, Holly Hill, Hampstead, London NW3 6RB. Tel: 01-435 2232. Please quote reference number VP/114. Closing date for applications: 15.8.1980.

## UNIVERSITY OF NOTTINGHAM

### Department of Psychology

A vacancy exists in the Psychology Department for a  
**GRADE 6 COMPUTER  
TECHNICIAN**

(male or female). Duties include the design/development of sophisticated on-line equipment for laboratory control plus routine maintenance of the Department's computer laboratory complex. The laboratory is based on a VME master computer with DEC GT40 and LSI 11 slave machines. Expansion of the system, including microprocessor based developments, is in progress.

Design experience with CMOS/TTL devices is essential and previous computer experience desirable.

Suitable qualifications include HNC (or equivalent) in a relevant subject or ONC with appropriate computer experience.

Salary in the range £4884-£5204 per annum.

Application forms can be obtained from the Establishment Office, University of Nottingham, University Park, Nottingham NG7 2RD, telephone 0115 951601 ext 2083. Ref No: PSY4/80.

### UNIVERSITY OF ST ANDREWS

#### Department of Anatomy and Experimental Pathology

Applications are invited for the recently established post of

## LECTURER

in the Department of Anatomy and Experimental Pathology. The successful candidate will be expected to participate in the teaching of

## HISTOLOGY AND CELLULAR PATHOLOGY

Previous experience in a Department of Pathology or Experimental Pathology is desirable. Excellent facilities for research and teaching. The Department may be visited by arrangement with Professor D. Brymorn Thomas (Telephone St Andrews 76161 ext. 7106).

Salary at appropriate point on scale £2620-£3140 (under review), starting salary probably not above £7410, plus FSSU/JSSU.

Applications (two copies preferably in typescript) with the names of three referees should be lodged by 10 August 1980 with the Establishment Office, The University, College Gate, St Andrews, Fife, from whom further particulars may be obtained.

## THE UNIVERSITY OF MANCHESTER

### RESEARCH ASSISTANT

Experimental psychologist with postdoctoral or similar experience, required by the Department of Occupational Health to carry out research on the effect of environmental factors on the performance of particular risks. Appointment up to two years, experience with computers and electronic/electronic equipment an advantage. Initial salary range £5052-£6068 per annum. Particulars and application form from the Research Department (157/80/NS) from the Registrar, The University, Manchester M13 9PL. Quote ref: 157/80/NS.

## CAN YOU TEACH?

If you are a young, enthusiastic graduate with the ability to explain 'A' level Science or Maths to teenagers we want to meet you. We are looking for enthusiastic teachers. **WANR**—an independent sixth-form college in central London and Birmingham, offering A-level courses or part-time teaching posts. small classes good pay no extra-curricular strings. Write with C.V. to: The Principal, 24 Elstaston Place, London S.W.1.

**BEDFORD COLLEGE**

University of London

MICROPROCESSOR

SYSTEMS PROGRAMMER

Applications are invited for the post of Microprocessor Systems Programmer to develop a wide range of applications of microprocessors in the Microprocessors Centre, newly established within the Computer Unit.

A sound knowledge of programming is required, together with at least one high-level language will be required. Preference will be given to candidates with a knowledge of Pascal and an interest in digital logic and microelectronics.

Salary in the range £5142-£8150. An appointment may be transferred to the range £5142-£9369 for applicants with considerable relevant experience, but the starting salary will not exceed £7139.

Further particulars and application forms from Personnel Officer, Bedford College, Regent's Park, London NW1 4NS, 01-466 4400 ext 312.

**UNIVERSITY OF KENT**

AT CANTERBURY

BIOLOGICAL LABORATORY

—RESEARCH ASSISTANT

Applications are invited from graduates in biochemistry, genetics, microbiology or equivalent to the post of Research Assistant to work on a gene-cloning project funded by the Wellcome Trust. The appointment would be for three years and it would be possible for the successful applicant to register for a higher degree by part-time study. Salary in the range £4402-£5052. Applicants should write giving details of qualifications and the names of two academic referees to the Senior Assistant Registrar, Faculty of Natural Sciences, Chemical Laboratory, The University, Canterbury, Kent CT2 7NH, by 15 August, 1980. Please quote Ref: A19/80/NS.

**UNIVERSITY OF OXFORD**

DEPARTMENT OF ZOOLOGY

Edward Grey Institute  
of Field OrnithologyPostdoctoral Research Ass't.  
Virus ecology of seabirds

Applications are invited for a postdoctoral research assistant supported by the National Research Council of Canada to work on the incidence of viruses in and their effects on seabirds. The work will be done in collaboration with the National Research Council Institute of Virology, Ottawa. Candidates should have a PhD in animal ecology or related areas. Field experience with seabirds and/or knowledge of microbiology would be advantageous.

Salary on Research Support Grade 1A. This is a one year appointment to start as soon as possible.

Further details are available from the Secretary, Edward Grey Institute, Department of Zoology, Parks Road, Oxford OX1 3PB (telephone (0865) 56789).

**UNIVERSITY OF READING**

LECTURESHIP IN GEOLOGY

Applications are invited for a Lectureship in Geology for a fixed period of three years. Candidates will be expected to teach geochemistry and non-clastic sedimentary petrology, leading to BSc degrees in Geochemistry, Geology and Geophysics and MSc in Sedimentology and its applications. Candidates should have a major research interest in geochemistry.

The person appointed should take up duties on 1 October, 1980, or as soon as possible thereafter.

Further information may be obtained from the Registrar (Room 214, Whiteknights House), The University, Whiteknights, Reading RG6 2AS, by whom applications should be received not later than 1 September.

**The University  
of Exeter****SRC Case  
Award in  
Chemistry**

The synthesis of compounds of potential agricultural importance. A joint project between ICI Plant Protection Division and Exeter University.

Applications are invited, from those holding or expecting to hold a First or Upper Second Class Honours degree in chemistry, for an SRC CASE studentship on the above project.

The investigation will be directed towards:

- The synthesis of transition state analogues as specific enzyme inhibitors
- The biomimetic synthesis of non-protein amino acids with insecticidal activity.

The project will be directed by Dr D. H. G. Crout of Exeter University, in collaboration with Dr D. J. P. Pearson of Jealott's Hill Research Station, Bracknell.

The successful applicant will be expected to register for PhD degree and must satisfy the SRC studentship conditions. In addition to the SRC studentship grant a supplement of £200 per annum, tax free, will be paid and the duration is for three years.

Further details are available from: Dr D. H. G. Crout, Department of Chemistry, University of Exeter, Stocker Road, Exeter EX4 4QD. Tel. 0392 77911 Ext. 367, to whom applications should be made as soon as possible.



Plant Protection  
Division

**Cambridge Water Company****Engineer for Telemetry-  
Telecontrol System**

Starting salary in range £5000-£7000

The Company has recently installed an advanced, microprocessor based, telemetry-telecontrol system for remote control of its water supply network. An engineer is required to assist in the development of operating software and displays. While several years experience in such systems is to be preferred, engineers and graduates with an interest in systems development will also be considered. Starting salary according to qualifications and experience. Assistance with housing, car allowance.

Applications to Managing Director & Engineer, Cambridge Water Company, Rustat Road, Cambridge CB1 3QS (Tel. Cambridge 47351) by 15 August.

**UNIVERSITY OF  
CAMBRIDGE**Department of Physical  
ChemistryPOST-DOCTORAL  
RESEARCH ASSISTANT

Applications are invited for a chemist interested in exploiting the synthetic potential of organic shale materials. Previous relevant experience in the chemical studies of clays an advantage. Salary according to age and experience. Duties to commence October 1980 or as soon as possible.

Candidates should submit their applications together with the names of two referees to Prof. J. M. Thomas, Head, Department of Physical Chemistry, Lensfield Road, Cambridge CB2 1EP, before 15 August, 1980.

American Type Culture Collection,  
Rockville, Maryland

**RESEARCH  
ASSOCIATE**

Position Available Immediately

Recent PhD with one or two years Post-doctoral training desirable. To aid in development of a Plasmid and Lambda Vector Collection. Will be expected to develop own Research Program. Salary £16-£15K. Send C.V. and References to:

Mr. Bobbie A. Brandon, American Type Culture Collection, 1201 Parklawn Drive, Rockville, Maryland, 20852, U.S.A. EOE/MF

**X-RAY TECHNICIAN  
(GRADE 5)**

in Soil Science Department, University of Reading, to take day-to-day responsibility for a laboratory with X-ray diffraction and fluorescence equipment and to provide an analytical service. HNC or equivalent qualification, good knowledge and some experience of X-ray analytical methods and equipment with knowledge of other analytical techniques applied to soil or rock. Salary in scale £4257-£4974 per annum (under review). Apply with details of qualifications and experience, full details of the equipment used, and names of two referees quoting Ref: TS32A to Personnel Officer, University of Reading, Whiteknights House, Whiteknights, Reading RG6 2AH.

St Mary's Hospital  
Medical School  
(University of London)  
Norfolk Place, London W2 1PG

**DEPARTMENT OF  
BACTERIOLOGY**

Requires MLSO for work studying mechanisms of natural and acquired immunity to bacterial infections in humans.

Qualifications required—HNC in Medical Microbiology or BSc in Microbiology.

Salary Whitley Council MLSO scale, minimum £3510 + £396 pa London Allowance according to experience etc. Apply to The Secretary at above address quoting AAG/1.

**TECHNICIAN (GRADE 3)**  
required in Plant Science Laboratories, University of Reading, to assist in Phytochemistry research and teaching units. Experience in analytical chemistry and/or chromatographic techniques essential plus at least OCN or similar qualification. Salary in scale £3594-£4257 per annum (under review). Apply with full details of experience and qualifications and names of two referees quoting Ref: TS25 to Personnel Officer, University of Reading, Whiteknights, Reading, Berks RG6 2AH.

# RESEARCH TECHNICIAN

Due to expansion of its R&D activities a world leading company requires a Research Technician to work in its R&D Department in London.

Applicants should have several years experience in the routine operation and maintenance of scientific equipment such as Electron Microscopes, X-Ray Generators etc.

Conditions of employment and benefits are excellent with a staff restaurant and non-contributory pension scheme with free life assurance.

Please send full details or write for an application form to:

Mr M. H. Boorman,  
17 Charterhouse Street,  
London EC1N 6RA

## IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Department of Biochemistry  
CHIEF ANIMAL TECHNICIAN

Applications are invited for the post of Chief Animal Technician (Technician Grade 1) to manage the day-to-day operation of the animal unit, which has a staff of six and a subsection at Silwood Park Field Station. Duties will include supervision of breeding colonies (rodents, felines and poultry), responsibility for cost control, training of junior staff and considerable involvement in varied research projects. Ideally candidates should have nine years' relevant experience, including animal husbandry techniques, co-operative care of a wide range of species, hold or be eligible for a Home Office licence. Associateship of the Royal Society of Animal Technicians is essential.

The post is superannuable: there is a generous sick pay scheme. The working week is 37½ hours, five working days, plus one and a half days in addition to public holidays at Christmas and Easter. There is a modern staff canteen and excellent facilities, with sports centre and swimming pool, season ticket loan scheme, after six months.

Salary in the range £564-£6612 inc (under review).

Applications, writing to: Departmental Superintendent, Department of Biochemistry, Imperial College, London SW7 2AZ, or enquiries to Mr G. Green, Tel: 01-580 5111 ext 1100.

## UNIVERSITY COLLEGE OF NORTH WALES, BANGOR POSTDOCTORAL RESEARCH OFFICER: CATABOLIC PLASMIDS

Applications are invited for the above post, to work in the College's Department of Biochemistry and Soil Science, in collaboration with Dr M. A. Williams, on the molecular biology of the *Tol* plasmids, determining the ability of host bacteria to degrade aromatic hydrocarbons.

Applicants should have experience in microbial genetics and/or molecular biological techniques.

The appointment, to commence on 1 October 1980, will be for three years, and will be to the Research and Analogous LA scale: £5052-£8768 per annum.

Applications (two copies), giving details of age, qualifications and experience, together with the names and addresses of two referees, should be sent to the Assistant Registrar (Personnel), University College of North Wales, Bangor, Gwynedd LL57 2DG as soon as possible.

Informal enquiries are invited by telephone to Dr Williams, Bangor (0248) 5151, ext 413.

# SCIENCE EDITOR-PULSE

An experienced Science Editor is required by *Pulse*, the nation's leading weekly medical news journal to take charge of the paper's clinical section.

The journal circulates weekly to family doctors and the Science Editor will be responsible for keeping readers up to date with the latest developments in medical science as it affects them.

The person we are looking for will be a science graduate who has demonstrated that he or she can combine journalistic flair with the ability to understand and write clearly about medicine. The job will entail writing clinical news and feature stories and commissioning articles.

An attractive salary will be negotiated and other benefits include 4 weeks holiday, rising to 5 with service, contributory pension scheme, free life assurance, and subsidised staff luncheon club.

Only applicants with previous journalistic experience will be considered.

Write to Howard Griffiths, Editor, *Pulse*, Morgan-Grampian Ltd., 30 Calderwood Street, Woolwich, London SE18 6QH.

The Borough is within easy reach of Central London and bordered by Epping Forest. London Addition to salary payable. All schools are excellently provided with full laboratory facilities, equipment and technician support to enable the teaching of modern syllabi.

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required for High Schools (11-14 years)/Senior High Schools (14-18 years) for both General Science and specialist Physics, Chemistry and Biology. Graduates without an education qualification will be considered. There may also be the opportunity for part-time/temporary work.

Application form and further details available on receipt of s.a.e. from Chief Education Officer, London Borough of Waltham Forest, Municipal Offices, High Road, Leyton, London E10 5QJ.



Waltham  
Forest

## UNIVERSITY OF OXFORD Dyson Perrins Laboratory POSTDOCTORAL RESEARCH ASSISTANTSHIP

Applications are invited for a postdoctoral research fellowship (supported by SRC) to develop a laser polarimetric method for measuring heavy atom kinetic isotope effects in organic compounds. Applicants should have experience in one or more of the following: (a) reaction kinetics, (b) building apparatus and (c) synthesis with organic compounds.

The appointment is initially for one year (from 1 October 1980, or up to six months later by agreement), and is renewable for a second year. The salary will be in the Research Support Grade 1A, the initial salary being not higher than £5725 per annum (under review) in the U.S.

Applications (one copy), with curriculum vitae and names and addresses of at least two referees (overseas candidates should ask for letters to be addressed to the address below) should be sent as soon as possible to Dr M. J. T. Robinson, Dyson Perrins Laboratory, South Parks Road, Oxford OX1 3QY.

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## UNIVERSITY OF SUSSEX School of Engineering and Applied Sciences POSTDOCTORAL RESEARCH FELLOW

Required from 1 October or as soon as possible thereafter to work on a year-long research project concerned with the development of a computer program and a test rig for evaluating the performance of aerofoil sections in bearings. The starting salary would be at the lower end of the scale for Research Fellow 1A, £5052-£6612 inc (under review).

Applicants should have post-graduate qualification in Mechanical Engineering and programming experience. Further information and application forms may be obtained from Dr R. Holmes, School of Engineering and Applied Sciences, University of Sussex, Brighton BN1 9QH. Tel: 0273 606755, ext 90.

## KING'S COLLEGE HOSPITAL CHIEF PHYSIOLOGICAL MEASUREMENT TECHNICIAN (CARDIOLOGY)

Applications are invited from those qualified and fully experienced in cardiac techniques for this challenging post which involves taking charge of the technical work of busy department at one of London's leading Teaching Hospitals.

Salary: £5945-£7316 inclusive.

Application forms and job descriptions available from Sector Administrator's Office, King's College Hospital, Denmark Hill, London SE5 8RS. Tel: 01-274 6222, ext 2408 quoting reference number SA/198.

Closing date: 8 August, 1980.



**UNIVERSITY OF STRATHCLYDE**

Applications are invited for a Postdoctoral Research Fellowship

to study the Thermodynamics of Liquid Nickel-Based Alloys in the

**DEPARTMENT OF METALLURGY.**

The project, which is supported by SRC, for a period of three years, would be suitable for metallurgists, materials scientists or physical chemists having an interest in high temperature systems. Some experience in high temperature experimentation would be an advantage. The activities of carbon, oxygen and other dilute constituents in Ni-Cr-Chromium-Iron alloys will be measured by a number of techniques.

Salary on Range IA of the national salary structure for research and analogous staff, commencing at £5725 per annum with incremental progression (under review). Superannuation benefit.

Applications (quoting R34/80) together with the names and addresses of two referees should be forwarded to Professor H. B. Bell or Dr R. J. Monfret, Department of Metallurgy, University of Strathclyde, Colville Building, 48 Portland Street, Glasgow, G1 1XH, from whom further information can be obtained.

**UNIVERSITY OF KENT AT CANTERBURY****RESEARCH FELLOW IN NETWORK DESIGN**

Applications are invited for a Postdoctoral Research Fellowship to work on an SRC-supported project involving the application of state-space techniques to the analysis and synthesis of microwave circuits and digital filters, including the development of mathematical models and computer programs for the design of distributed-parameter networks. Candidates should have a PhD degree in Computing, Electronics, Physics or related subjects and relevant experience in computer-aided design techniques would be an advantage. The appointment is for one year and salary would be in the range £5052-£5275.

Application forms and particulars may be obtained from the Senior Assistant Registrar, Faculty of Natural Sciences, Chemical Laboratory, The University, Canterbury, Kent CT2 7NH. Closing date for applications: 29 August, 1980. Please quote ref: A20/80/NS.

**THE MEDICAL COLLEGE OF ST BARTHOLOMEW'S HOSPITAL (University of London)**

West Smithfield, London EC1A 7BE

**POSTDOCTORAL RESEARCH FELLOWSHIP IN ENZYMOLOGY**

Applications are invited for a Postdoctoral Research Fellowship supported by the SRC to work in the Department of Biochemistry with Dr J. B. Lee on the mechanism of action of the cysteine proteases using cryoelectronmicrography and rapid reaction techniques. The post is available for 3 years from 1 October 1980 (entry date, revised) £4750 per annum including London Weighting. Applicants should have a PhD in chemical enzymology and an interest in kinetics.

Applications, with curriculum vitae and names of two referees, should be sent as soon as possible to The Secretary of the Medical College at the above address, quoting reference 895.

**STUDENTSHPHS****IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY**

Department of Mechanical Engineering  
RESEARCH  
ASSISTANTSHIPS AND STUDENTSHIPS

are newly available at Imperial College, London, in a very active group having strong links with industry in the energy field. Attractive salaries depending on qualifications and experience. Applications welcomed from good post-doctoral candidates holding at least an upper second-class degree. Applications and enquiries should write to Dr F. C. Lockwood, Mechanical Engineering Department, Imperial College of Science and Technology, London NW1, London SW7 2BX, with a curriculum vitae and names of two independent referees.

**UNIVERSITY OF YORK****Department of Biology****A THREE YEAR SRC/CASE RESEARCH STUDENTSHIP**

is available to work on the biochemistry of fatty acid abnormalities in the central cells of plasma in multiple sclerosis. The project is jointly with the Leeds Regional Blood Transfusion Service, and Dr A. J. Tolson.

Applicants should have a good degree in a biological science and should apply with a curriculum vitae and the names of at least two referees to Dr M. G. Rumsby of the Department of Biology.

**UNIVERSITY OF DURHAM  
DEPARTMENT OF CHEMISTRY****CASE STUDENTSHIPS**

Applications are invited for the following CASE awards:

1. Electrochemical Synthesis (Professor R. D. Chambers)
2. ESCA Studies of Electronic Surfaces (Professor D. T. Clark)
3. Spectroscopic Studies of Adsorbed Species (Dr J. Howard)

Some extra payments in addition to the normal SRC rates for research students are available for this award. The group is modern, research orientated, and possesses a very wide variety of physical and chemical techniques available to all research workers within the Department. Applicants should hold, or expect to obtain, a good honours (1-2) or post-graduate (1-3) second class honours degree in chemistry (1-3) or chemical physics (2-3).

Further details may be obtained, from the address indicated, by writing to the Chemistry Department, University of Durham, South Road, Durham DH1 3LE.

**UNIVERSITY OF LIVERPOOL****Department of Organic Chemistry****CASE STUDENTSHIP**

Applications are invited for an SRC CASE Research Studentship, available from 1 October 1980, or work on the design of new extracting groups for amines and their application in organic synthesis. The project is supervised by Dr D. J. Williams and is sponsored by ICI Ltd, Pharmaceuticals Division.

Applications, including the names of two referees, should be sent to the Research Department, The University, PO Box 147, Liverpool L69 3BX. Quote Ref: RV/500/NS.

**UMIST****RESEARCH ON THUNDERSTORM ELECTRIFICATION, CLOUD PHYSICS, PLASMA PHYSICS****Applications are invited for:-**

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- (3) A one-year studentship for MSc by research on ice nucleation.
- (4) One studentship for experimental study of nonlinear effects and plasma instabilities in the magnetosphere, for a joint programme on a collaborative project on magnetic field configuration in reversed field pinch plasmas.

Both projects are relevant to controlled thermonuclear fusion research. Applications, giving the names of two academic referees, should be addressed to Dr C. J. E. Kempster, Postgraduate Administration Officer, Department of Pure and Applied Physics, UMIST, PO Box 88, Manchester M6 1QD (Telephone 061-236 3311—Extension 2050/1910).

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Applications are invited from graduates holding, or expecting to gain, a Good Honours Degree, for SRC-CASE and industrially funded grants to carry out research, leading to the award of a higher degree, on the following topics

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- CANCER/VIRUS CHEMISTRY

Applications, including the names of two referees and a curriculum vitae should be sent to Dr J. B. Lee, Bayfordbury Research Laboratories, HERTFORD SG13 8LD, from whom further details may be obtained.

**THE OPEN UNIVERSITY****Case Studentship in Sports Science**

to work on the DESIGN and TESTING OF NEW SPORTS RACQUETS in collaboration with ELITE SPORTS INTERNATIONAL LTD. Applications for further particulars are invited from good honours graduates in physics, materials science, sports science or any appropriate branch of engineering, who should apply to the Director, Faculty of Technology, The Open University, Walton Hall, Milton Keynes, MK7 6AA (0963 63437).

The successful candidate will register for a PhD. Please quote reference (TMN).

**THE CITY UNIVERSITY****Molecular Studies of Drugs GRADUATE IN PURE SCIENCES/LIFE SCIENCES**

Applications are invited for an SRC Research Studentship, commencing 1 October, 1980.

Drug design and the molecular basis is a field of research in which we have been active for some years. It includes experimental and theoretical studies of molecular structure and charge distribution, involving a variety of approaches and collaboration with other laboratories.

This is a multidisciplinary research and interested graduates in pure sciences/life sciences with a Class I or II (1) degree should contact Department: E. G. Stewart, City University, Northampton Square, London EC1V 0HB. Tel: 01-253 4399, ext 215.

**Polytechnic of the South Bank  
Department of Mathematical Sciences & Computing****SRC CASE RESEARCH STUDENT IN APPLIED MATHEMATICS**

Good honours graduate (1 or 2i) in Mathematics or Physics or Computing for an SRC CASE Studentship in association with British Steel Corporation to carry out research into the mechanical properties of large load bearing rollers used in continuous cold rolling processes. Candidates should have a good knowledge of numerical methods and computing; they should be able to solve problems involving thermal and mechanical stresses. Applications will be registered with the Polytechnic of the South Bank. Starting date: October 1980. Salary: approx. £3200 (fix free).

Apply to K. H. Oka, in the Dept., Borough Road, London SE1 8AA.

**THE CITY UNIVERSITY****Department of Physics  
SRC/CASE STUDENTSHIP**

The Physics Department is co-operating with Rollers Measurements Devices Ltd, of London SE Edmunds and offers an opportunity to a well qualified British graduate to be one of the Physical Sciences to work in advanced thin film technology.

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Apply to Dr D. W. Stamps, Department of Physics, The City University, Northampton Square, London EC1V 0HB. Tel: 01-253 4399, ext 215.

**IMPERIAL COLLEGE  
UNIVERSITY OF LONDON  
DEPARTMENT OF CHEMICAL  
ENGINEERING AND  
CHEMICAL TECHNOLOGY**

**SRG CASE  
STUDENTS**

Applications are invited for an SRC CASE Studentship to work in collaboration with BP Research Centre, Sunbury-on-Thames, on

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Applications, including the names of two referees, should be sent to: Dr G. C. Metland, Department of Chemical Engineering and Chemical Technology, Imperial College, London SW7.

**KING'S COLLEGE  
University of London  
Department of Chemistry  
RESEARCH STUDENTS**

Applications are invited for a number of SRC (CASE) Studentships tenable from October 1980 and leading to the PhD degree. Projects include the following. Supervisors and co-operating bodies are given in parentheses.

Steric and electronic factors involved in chiral recognition and discrimination (Professor S. F. Mason, May and Baker); nucleophilic addition-elimination and cyclotrimerisation (Professor C. B. Reese, G. D. Searle UK); chemical modification of proteins (Professor Dr. I. John, Beecham Pharmaceuticals Ltd); synthesis of potential thromboxane antagonists (Dr D. I. Davies, Glaxo Group); protein reactions in emulsions (Dr J. E. Crooks, ICI Corporate Laboratory).

Applicants should hold, or expect to obtain First or Upper Second Class Honours Degree from UK universities (or CNAAs) or Grad RIC of equivalent standing.

Further information and application forms from: Professor V. Gold, FRS, Department of Chemistry, King's College, Strand, London WC2R 2LS.

**BRUNEL UNIVERSITY  
Department of Physics**

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studentships**

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2. A Physicist to learn the technique of electron spectroscopy at AERE HARWELL and apply it to the study of liquid metal alloys.

Replies from graduates with 1st or upper 2nd degrees to: Prof. A. M. Hogarth, Dept. of Physics, Brunel University, Kingston Lane, Uxbridge.

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**UNIVERSITY OF BATH**

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Pharmaceutics**

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For further details, contact Dr. J. Macklin, Pharmaceuticals Group, School of Pharmacy and Pharmacology, The University, Bath BA2 7AY.

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**Department of Physics  
MSC COURSE: TECHNIQUES  
IN MOLECULAR PHYSICS**

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**MEETING**

"Reactions in Nuclear Engineering Research", Cambridge, 19 September, 1980. Co-sponsored by Science Research Council and the Institution of Nuclear Engineers. Programme, literature, fees and full details from: Institution, 1 Penerley Road, London SE6. (Tel: 01-698 1500.)

**THE UNIVERSITY  
OF ASTON  
IN BIRMINGHAM**

**DEPARTMENT OF OCCUPATIONAL  
HEALTH AND SAFETY**  
(formerly Department of Safety and Hygiene)

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**The Department of Occupational Health and Safety  
(formerly Department of Safety and Hygiene)**  
University of Aston in Birmingham, Gosta Green, Birmingham B4 7ET Tel: 021-359-3611 ext 6238 Quote ref: 80/1.



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Faculty of Education, Castle View,  
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For full details and an application form contact: Richard Braun, Middlesex Polytechnic, The Burroughs, Hendon, London NW4 4BT. Telephone 01-202 6545.

# Ariadne

■ I've never understood the term bird-brained as equivalent to idiocy except perhaps as applied to pigeons, who seem quite remarkably stupid. But starlings, for instance, are clever, not too proud to learn and are clamorously hanging upside down on a bag of nuts as I write, having taken a tip from the bluetits.

The same adaptability appears to apply to white storks. They migrate across the Algerian Sahara. A report in *Oryz*, the Fauna Preservation Society's journal, says that they have taken up night flying and ceased daylight navigation. That's because there are oilfield gas flares about every 5 kilometres. The storks swoop down, get into the thermal rising from a flare and gain height to plane down to the next. Apparently, as many as eight thousand storks have been seen doing this in one night. There is no discussion of why they don't do the same thing by day. Perhaps the storks' daylight vision is not good enough for them to distinguish the flares.

■ West End clubs are not usually on my beat, as journalists in American TV features say. But I was taken to lunch the other day at the Naval and Military in Piccadilly and was unexpectedly impressed, not by the surroundings, which were elegant enough for anyone, but by the fact that the wines were in the charge of a woman.

No militant for women's rights am I, as may be inferred from the sentence above carefully avoiding the dreadful, stupid and unnecessary "wineperson". But full marks to what I believe is called the "In and Out". I expected it to be full of beefy-red-faced defenders of a masculine stronghold. If it goes on like this they'll be letting women use the front entrance next.

■ It was de Maupassant, I believe, who wrote a short story with the horrendous theme of monsters to order. A pregnant woman, poor as the French equivalent of a church mouse, bound and corseted herself tightly enough and oddly enough to produce a malformed child, later sold to a circus for a sideshow. If it was not like de Maupassant, I've no doubt that some-one will write and correct me.

That's a somewhat hyperbolic introduction to my reaction to teen-aged tennis phenomena. There's something monstrous about them. They have obviously been trained to play tennis from unbelievably early ages, relentlessly coached by older people. The same thing goes on with adolescent and pre-adolescent gymnasts. Some years ago there was an outcry about training baby swimmers. How long, now there's money in it, before the opening batsmen for England will be aged 11 and 13?

■ I hope that I receive a letter from the Division of Biology at the California Institute of Technology in Pasadena about research going on there concerned with zebra finches. It seems utterly pointless



to me and I would like to be told what the point is.

Zebra finches' are like plenty of other birds in that the male bird sings and the female doesn't. Behavioural dimorphism, this is called and, further, it is explained that it is correlated with the presence of morphological sex differences in the neural substrate that mediates this behaviour, the song system. I take this to mean that the male zebra finch has the organs, the nervous system and the brain centres for singing.

What if female zebra finches were given doses of male hormone? Well, female zebra finch chicks have been treated with such hormones. They developed masculinised morphology and functional capacity for song. The details in the report I've been reading are confusing but as far as I can make out, females were then implanted with one of two other male hormones. One of the hormones induced the females to sing as if they were male birds. There was one bird at least that also showed the courtship behaviour of the male. The others remained mute. We may conclude, I think, that doses of male hormone given to a female will induce masculinisation in the body and will also induce male behaviour. Which isn't entirely a discovery. There must be something I'm missing.

I haven't been so puzzled since I read, years ago, that the American Air Force had been financing research into holes in teeth, whether feeling them with the tongue gave a true impression of their size. Radios? Microfilm? Poison pills? I never found out.

■ Ordinary sound is a longitudinal wave motion: each air particle oscillates in the line of advance of the wave. Transverse wave motions with a sideways oscillation (like a wobble in a rope) can be transmitted through elastic solids but not through fluids, because they

offer no resistance to such shearing motions. So at least the physics textbooks claim. But my heterosocial friend Daedalus points out that fluids do offer transient resistance to shear. On a short enough time-scale they behave much like solids—which is why you can skip a stone on water—and so transverse sound should be possible at suitably high frequencies. Because liquids and gases deform much more readily than solids, transverse sound will be very slow in these media—only a few tens of centimetres a second, Daedalus calculates. Furthermore, higher frequencies will travel faster than lower ones. Armed with these predictions, DREADCO physicists are devising loudspeakers to stir up fluids in side-to-side vibrations, rather than the usual forward-and-back mode. Transverse sound should be transmitted most readily through a thick viscoelastic medium. So by immersing one's head in a large bath of tinned mushroom soup with a transverse-vibration speaker at the far end, it should be easy to sense transverse sound directly. It should have a haunting, poignant quality, unconsciously recalling the security of the womb where the fetus, immersed in the somewhat viscoelastic amniotic fluid, last heard it. But transmitting it intelligibly over any distance, even in air, will pose problems. Its slow rate of travel, and the faster pace of the higher frequencies, means that a signal will arrive after noticeable delay as a shrill descending warble, with the separated frequencies sweeping past in turn. Thus by delaying the high frequencies electronically, one could arrange that they would catch up and deliver a meaningful message only at one specified distance from the speaker. This would be useful on railway stations or military parade grounds for addressing chosen platforms or squads. And the emotional quality of the new sound might mollify the more unwelcome commands.

# Spiders

E.O. Wilson: Let me remind you that people everywhere, a large percent of the population, at a very early age have already developed a deep horror at the sight of snakes or spiders with nothing more than gentle nudging from their parents, if that. Yet, in spite of the fact that parents constantly reinforce their children against going near electric sockets, automobiles, knives and the like, phobias against such objects rarely develop.

Marvin Harris: Let's go back again to the possibility that these phobias are genetically programmed — which I'm willing to grant. The overwhelming bulk of the socially conditioned response repertoires of different human societies consists, by your own admission, of culturally determined rather than genetically determined traits. Then it seems to me that when one offers a cogent culturological explanation of these phobias, it has to be considered that this offered in isolation.

... from a debate between E.O. Wilson and Marvin Harris on sociobiology. In *The Sciences*. From family constellations to galaxies, *The Sciences* takes the critical look. Handsome, original, lively, *The Sciences* represents the best science commentary you'll find anywhere on human behavior, culture, the physical sciences — by Ashley Montagu, Stephen Jay Gould, B.F. Skinner, Napoleon Chagnon, Peter Medawar ... Subscribe today. It's only £9.00 a year.

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... instances of human such gigantic phenomena as the emergence of state-organized societies or the emergence of stratified classes and castes. The enormous differences between industrial civilization and



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